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Electric Power in Mining. PERHAPS the most prominent feature of the electrical industries at the present time is the general activity in the application of electric power for the performance of heavy work and in larger units than have formerly been called for. This is especially noticeable in the mining industry, where the flexibility of the electric motor makes its use more economical than other methods of power application and in many cases makes it possible to work mines that would otherwise be worthless. The important part which electricity plays in the work of the mining engineers is shown by the large share of attention given to it at the annual meetings of their national society. Our columns this week also bear evidence of this fact, as our readers will find several articles touching upon the various phases of this important use of the electric motor.

Measuring Instruments. THE improvements in the d'Arsonval galvanometer and the description of a very convenient and simple test-room method for measuring large currents, described in another column, cannot fail to be of use and interest to those engaged in this class of work. Prof. Ayrton, with his associates, has perhaps worked more than any one else in this field, and the conclusions he comes to may be relied upon as being very safe examples to follow. The d'Arsonval galvanometer, used so largely in Europe, has, strange to say, not been adopted in this country as much as its good characteristics would warrant. This may be due in a measure to the high class of standard volt and ampère meters used here, based upon a modification of the same principle. But there is still a wide field where greater ranges, or greater sensitiveness, are required, and for these cases the d'Arsonval form is without doubt unequaled. The method described in that article for measuring from 5 to 1,000 ampères with such cheap apparatus ought to be studied by any one who has to arrange measuring instruments for such measurements.

Welding. THE subject of electric welding is one in which much work and little talking is done. Those who have no opportunity to follow the work done in this field might think from the small amount of published matter that it was not doing what was at first promised by it Meanwhile, however, much quiet work was done, and at present this process is not only used in many industries, but it has enabled other things to be done which before were impossible, such, for instance, as the butt welding of stranded iron and steel cables. A European wire drawing factory took pride some years ago in their ability to deliver exceptionally long lengths of wires. Electrical welding renders this a very easy matter. As will be seen in an article we publish in this issue, one of the chief applications is in the wire industry, where its use will probably become imperative before long, owing to competition. It is of interest to note here that it was this feature, namely, the butt welding of copper wire (used for winding large coils on dynamos), which led Prof. Thomson to the idea of doing it electrically, so that a splice could be made by the workman while he was winding his magnet, and without making the slow and expensive hard soldered joint.

The Transmutation of Alternating Currents. THE paper by Lieut. F. Jarvis Patten, read recently before the American Institute of Electrical Engineers, offers some very ingenious methods of changing the character of alternating currents, so that in the electrical transmission of power the final form of current may be one perhaps better suited for practical purposes than the simple alternating current. For example, it is possible by his apparatus to start with a plain alternating current and emerge with the direct or a three-phase current; or to start with any of these and emerge with another. This is accomplished by ingenious modifications of dynamo and motor having several collecting rings and divers arrangements of brushes. The apparatus is really exceedingly ingenious and reflects great credit on the inventor, but we have serious doubts whether such devices will find their way into heavy engineering practice. To rectify an alternating current is a particularly exasperating task on account of the danger of sparking that is likely to be encountered if large currents are used, and even after it is rectified such a current is hardly the equivalent of an ordinary direct current. For practical purposes, when such transmutations are necessary it is altogether probable that the most satisfactory solution will be found in using a generator and motor of any convenient kind for the actual transmission, and then coupling directly to the latter a generator, or generators, of whatever sort may best serve the purpose in hand. Under these circumstances there are no complications of winding, no fear of sparking, no extraordinary forms of machines to be developed; everything is perfectly straightforward and simple, and simplicity in electrical matters is a virtue the importance of which can scarcely be overestimated.

Difficult Line Construction. THE long distance transmission of power in the mountainous mining regions of the West has necessitated a class of line construction which has not before been needed in lighting and power plants at ordinary altitudes. A good example of this is shown in our columns this week, in the description of a Western mining plant. The difficulties encountered in the construction of a line such as that required for the operation of the Edison plant at Ouray, Colo., are decidedly unique in their character. In this plant, as in others recently constructed in the Colorado and Nevada mining regions, at altitudes ranging from 9,000 to 14,000 feet, it was often necessary not only to cut a path for the line through dense timber, but to carry it up the mountain side at an angle of 45 degrees with the horizon, and to blast out a road for it through the projecting rocks and crags. Another feature that required careful consideration in the planning of the line was the fact that it is practically inaccessible for nine months of the year, as the mountains are so completely buried in snow that it is extremely dangerous for any person, even though well acquainted with the treacherous character of snow slides, to venture a trip over the route which the line is compelled to follow. This renders it necessary to build a line which is thoroughly reliable and which is not likely to be interrupted by the frequent snow slides in the mountain gorges. The satisfactory operation of the line at Ouray as well as the lines at Telluride and other places indicates, however, that American engineers are fully able to solve the problems presented in the construction of lines for this character of long distance transmission, and it is likely that in the near future a large number of similar plants will be put in operation carrying the power of mountain waterfalls over almost inaccessible summits to be utilized in working the mines. Indeed, a number of these are already projected, in which power will be transmitted over distances varying from 15 to 50 miles.

The Finances of Electric Lighting. MR. ERASTUS WIMAN'S discussion of electric lighting from a financial standpoint, at the Buffalo meeting of the National Electric Light Association, contained many very suggestive hints for the contemplation of certain station managers. While a well conducted electric light station in a favorable situation is undoubtedly a most secure and remunerative investment, it is only too true that in the development of the art there has been many a plant established which has involved its managers in financial difficulties from which they have never been able to extricate themselves. As Mr. Wiman suggested, this is partly due to the fact that ruinous competition was entered upon, the public were given the impression that electric light could be had for little or nothing, and plants were put into operation without due consideration of the conditions that must be met. Part of this unfortunate state of affairs is unquestionably due to the natural enthusiastic over-confidence that came from the development of a new and magnificent industry. But there are two other causes which had a hand in the mischief, one, an inordinate desire on the part of commission agents to sell apparatus in places where nothing but a miracle could establish a paying plant, another was the desire of some who rushed into the business to obtain dividends without capital. The former case accounts for the existence of plants in locations where, through small population or severe competition, there is not enough business to give them a reasonable excuse for corporate existence. The other accounts for installations where depreciation wrecks the last hope of dividends. Fortunately time has wrought changes in the electric light industry and neither of these conditions is so frequently met as used to be the case. To get good dividends it is necessary to have a well installed and well managed plant in a situation where a reasonable amount of paying business can be secured. For such investment there is plenty of opportunity, and those who enter the electric lighting field on such a basis are not likely to be disappointed. Mr. Wiman did a good work in laying stress on this financial side of the electric lighting question and impressing the necessity of careful management and shrewd business judgment in the establishment of an industry that is so closely allied to the public welfare as that of electric lighting.

Niagara Falls-Buffalo Transmission. AT the Buffalo convention some figures were given of a proposed plant for transmitting power from Niagara Falls to Buffalo. We publish this week as complete a description of this proposal as can be obtained at present. Owing to the competitive bids of various companies the full particulars cannot yet be published. The size of the units determined upon by the Niagara company, namely 5,000 h. p., is so far beyond anything yet attempted, excepting only the Ferranti machines at Deptford, that it opens quite a new and interesting field in dynamo construction. The price of the whole installation as proposed by this firm is reduced to $36 per horse power for units of 5,000 h. p., including generator, line and two sets of transformers. To American firms used to the artificial stimulus of a government protection, this figure appears exceedingly low, as it is claimed that transformers alone cost more than that per horse power. From the list prices of some of the prominent dynamo builders of this country taken from our government report of the Paris exhibition of 1889, it appears that the price of dynamos from 5 to 150 kilowatts varies from $50 to $70 and over per horse power; $36 for the complete plant therefore seems to be almost below the possible limit. It should be remembered, however, that with such large machines the price per horse power is naturally reduced very greatly. From the same report it appears that the prices of some of the European dynamos are as low as $18 per horse power for a 40-kilowatt machine of a French dynamo, the same for an English one of 33 kilowatts, $21 for a Swiss of 220 kilowatts, and others equally low. This shows that the prices in Europe are, as a rule, very much lower than in this country, while the machines are by no means poorly built. If now we combine these figures with the fact that the unit is out of all proportion larger than the present dynamos it is not likely that the price given for the Buffalo transmission is too low to be credited. From other sources we are led to believe that this price is f. o. b. Antwerp, and that therefore the freight and duty will raise it nearly if not quite to American prices. As to the criticism that the three-phase system is still experimental, it ought to be said here that while some have been waiting developments others have been busy making developments, and among the latter are chiefly the two companies who have earnestly endeavored to find out whether or not this system can be made a success. If now they are ready to risk their reputation by introducing it on a large scale, no better proof could be had that they now consider it beyond the experimental state. If it gives reasonable assurances of being a success petty national rivalries ought not to interfere with its introduction by a foreign firm.

Latest Foreign Electrical News.

(By Cable from Our Own Correspondent.)

LONDON, March 7, 1892.—The evidence in the Lane-Fox distribution patent case has proved to be of considerable length. The court has now been taking testimony for eight days, and a large mass of interesting evidence as to the state of knowledge of electric lighting in 1878 has been presented. What will be the result of the suit cannot now, of course, be predicted, and it is expected that a good deal of additional evidence will yet be introduced.

The agitation against the present telephone service in London continues unabated. The number of opposition telephone bills introduced is unprecedented. Already 250 adverse petitions have been presented.

Since incandescent lamp litigation has occupied so much of the public attention for the last few months, it will be of interest to lamp manufacturers to know that the Edison-Swan company has succeeded in preventing the Sunbeam company from manufacturing high candle power incandescent lamps.

The recent action of the insurance companies in raising the rates 30 per cent. on the Crystal Palace during the electrical exhibition now being held there is causing considerable discussion among the electrical companies, and is likely to result in a determined attempt to form an electrical insurance company.

Power Transmission from Niagara Falls to Buffalo.

A recent communication from the Oerlikon company, in Switzerland, gives some interesting information regarding the proposition which they have made for transmitting power from Niagara Falls to Buffalo. It will be remembered that this company was one of the two which designed and erected the now famous Lauffen-Frankfort plant. The Oerlikon and the Bérlin company have experimented perhaps more than any others with the three-phase system on a large scale, and they ought, without doubt, to be the best judges as to its practicability. A large part of the business of this company is the building of very large machinery, and they are therefore well equipped with factory facilities for dealing with such large pieces as enter into the construction of huge machines. They have been very busy experimenting with this three phase system since the closing of the late exhibition, and they now no longer consider this an experimental system. They are now nearly prepared to enter the field with machines and apparatus of standard sizes.

In submitting these projects, the Oerlikon company has aimed not only at proposing the very latest and most improved system, but also to keep within such limits as previous experience has shown them to be perfectly successful in every way. As was stated in an article which appeared in these columns a few weeks ago, the units at the Niagara stations are to be 5,000 h. p. each. The distance to Buffalo is 32,000 metres. One of the advantages in their proposed plan is not only to transmit the power from the Falls to Buffalo, but to adopt such a system as may be used directly in Buffalo without the use of any regenerating plant other than large transformers of high efficiency. An important feature of the project is therefore that the system should be equally well adapted for running arc lamps, incandescent lamps and motors. They have, therefore, proposed the use of the three-phase current, as they claim that this is at present, and will be for a long time to come, the only practical form of current for running large motors at a fair efficiency.

For running arc lights, the frequency of alternations must not be too low, while for running motors it should not be too high, for otherwise it would require either a very large number of poles or a very high speed in the motors, both of which are objectionable. It is also claimed that the line will be more efficient when the number of alternations is low, because in that case the capacity and induction effects on the line are reduced; this, on such a long line, is of considerable importance. The frequency which they have proposed is 50 periods per second, which they claim is about as low as can be used for arc lamps. The Lauffen plant is said to have had a frequency of about 40 periods, which would be too low for arc lighting.

In designing the huge 5,000 h. p. dynamos many points had to be considered. Among them was the fact that they have to be handled by existing means of transportation, especially if made in Switzerland and erected at Niagara Falls. Above all, these machines must be made as substantial and reliable as possible, as the units are so large that the failure of one of them means a reduction of 5,000 h. p. in the output of the plant. They therefore claim that the machines dare not be experimental in character, but must be perfectly reliable in every way. The shafts are to be vertical, as explained in our previous article, so as to connect the turbine at the bottom of the shaft to the dynamo at the top directly, without any gearing or transmission of any sort. We were informed that manufacturers of gearing had positively declined to make any proposition for gearing to transmit such a large amount of power. The dynamos are on the surface instead of at the bottom of the pits in order not to subject them to the moisture which must necessarily exist at the bottom of these shafts.

The speed of the turbine has been fixed at 250 revolutions per minute and the diameter of the armature at 330 centimetres, or about 10 feet. It is to be wound as a drum armature, but this does not mean, of course, that the windings are to extend across the ends of the armature, as in the usual drum windings; they are wound, as in many of the large multipolar machines made in Europe, on the outside cylindrical surface of the armature, forming what looks like a Gramme ring with wire only on the outside. The windings of the armature are made of bars or rods capable of carrying a current of 2,000 ampères. As in the case of the machine used at Lauffen, the armature winding will consist of three separate windings symmetrically placed, generating currents of 120 degrees difference of phase. Each of these currents will be 2,000 ampères, with a potential of 600 to 700 volts. The armature, and not the field, will in this case form the moving part, the reason being that it is desirable to have the least possible weight on the vertical shafts, as the armature weighs considerably less than the fields. This requires that the current must be led through contact rings, which they claim is not at all objectionable if these sliding contacts are suitably designed. The armature is perfectly smooth, and insures absolutely noiseless working. The field is to have 24 poles, which are very easily removed to facilitate repairing both the field and the armature. The whole machine is of circular shape, and has a platform above the field and armature for affording easy access to the slide rings and the top bearings. The machine is strictly mechanical in all its parts, and is substantially rigid, although no piece exceeds, either in size or weight, what can be readily handled on railroads and in existing workshops. They are to be separately excited, and the efficiency is to be in the neighborhood of 96 per cent., including the exciting power. Special care has been taken in providing for ventilation of the parts of the dynamo. It might, perhaps, seem that a dynamo of 96 per cent. efficiency ought not to require much ventilation, but it should be noticed that the four per cent. loss in this case represents a loss of 200 h. p., most of which is turned into heat.

The current from the dynamo is led into two step-up transformers in series. Two transformers are used, because it was found that a transformer of 5,000 h. p. would be beyond practical limits. They are to be artificially ventilated, and only the high pressure coils will be placed in oil. Any trouble while working can therefore be discovered and localized at once, which is an important feature. They are mechanically linked together, as were those used at Frankfort, and are to transform up to 25,000 volts, which the manufacturers say can no longer be looked upon as a venture in view of the success they have had with their experimental plant. A higher pressure, they say, would not be desirable, because the distance is not very great and the cost of the line is quite small, being only about $20,000, which is less than 10 per cent. of the whole. They state that 20,000 volts will be very nearly as economical and consider this voltage to be quite safe.

They propose to carry not more than one or two units on one line of poles and say that 5,000 or 10,000 h. p. can be carried on wooden poles at a very moderate initial cost of plant, while any increase of the amount of power on one line would require expensive supporting structures. They claim it is cheaper to erect a new line of poles for subsequent additions to the plant than to construct at present an expensive supporting structure adapted for future needs. Furthermore, they say that storms will not be so likely to shut off the whole supply of current from Buffalo if there are a number of separate lines, and there would be left the means to throw the current of any one line, that may be injured, on to another which would then simply work with double the loss, requiring, therefore, only a slight increase in the primary voltage.

The lines are to terminate in one or more step-down transformer stations which convert the current down to about 1,800 or 2,000 volts, at which it is then carried through the streets similarly to the systems at present in use, being transformed down farther at the place of consumption. They propose to separate the currents for distribution into two systems, one in which the regulation is very good and which is suitable for incandescent lighting and small house motors; the other system to be used for large motors only. On account of regulation, the circuits for lights must not have a large loss in the lines, while for motors considerable drop may be allowed, thus cheapening the cost of the lines. Experiments have shown that the speed of the motors in this system does not depend on the voltage, within very large limits, but merely on the number of periods. Power circuits can therefore be built much more cheaply than the light circuits, as the drop may be much greater. They claim it would be desirable also to control large power consumers, as manufactories and shops, directly from the distribution station. As to whether they will divide the current into light and motor circuits at Buffalo or at the primary station at the Falls is yet an open question. Several lines of 5,000 to 10,000 h. p. being separately established, both could be done and much trouble avoided that would be made possible by switching on or off a 5,000 h. p. dynamo.

The cost of the electrical part of the proposed plant they give as $180,000 for each unit of 5,000 h. p. This includes generators, exciters, the transformers at both ends of the line and the line itself, the efficiency guaranteed being 84 per cent., measured at the low pressure terminals of the secondary transformers. It should be noticed that this does not include the motors, which are supposed to be paid for or rented by the consumers themselves. This price is equivalent to $36 per horse power, of which $4 is for the line and the rest is for the generators and transformers. It will be noticed that this figure is exceedingly low and doubt has been expressed by American manufacturers whether it would be possible to erect the plant at this price. It should be remembered, however, that in the first place a company of the size and experience of the Oerlikon company is probably perfectly capable of making an estimate which will not be far from the true figure; secondly, that the price of the dynamo per horse power is reduced very materially when it comes to making units of such large sizes. One has only to compare the price per horse power of small dynamos with those of large ones to see how very rapidly this figure will decrease. When it comes to very large sizes it would cost nothing like double as much to increase the capacity of a dynamo 100 per cent.

Recent Improvements in the d'Arsonval Galvanometer.

BY W. E. AYRTON.

(Abstract.)

In a discussion on the methods and apparatus used by an engineering firm for measuring large currents, Prof. Ayrton described some improvements in the d'Arsonval galvanometer made by him and his associates which are of interest and importance. This galvanometer is, of all sensitive instruments, one of the most satisfactory, and has already become a standard instrument in laboratories and test rooms in Europe. In this country it is known chiefly in the form used in the Weston instruments, the essential difference being that in these a spiral spring is used as a counter force instead of a straight wire suspension. It will be remembered that in the d'Arsonval galvanometer the relative positions of the needle and the coil are exactly the reverse of those in the usual galvanometers. The coil in this case is movable, and the magnet (the needle in the ordinary galvanometer) is fixed, and is so large and powerful that the earth's magnetism may be neglected in comparison with it.

The objects sought after by Prof. Ayrton, in making these improvements, are to make the instrument as sensitive as possible, to decrease the number and amount of the errors and corrections, and to make the deflection as nearly as possible proportional to the current.

Suspension.—From calculation and experiments it has been found that for suspending the coil a phosphor-bronze strip is much better in a number of ways than the usual German silver wire. German silver has not only more subpermanent set than phosphor-bronze, but it is a substance that easily undergoes chemical change in the atmosphere. An instrument in which the coil is suspended with German silver wire will therefore have not only a greater zero error, but its sensibility will change more rapidly with time. Some makers use a circular platinoid wire, but this is said to have the objections possessed by the German silver with the additional disadvantage, in the case of coils of low resistance, that the specific resistance of the platinoid is even higher than that of German silver, so that this method of suspension introduces a resistance of 10 ohms into the galvanometer when the platinoid wire is employed.

He then showed by calculations based on the relative dimensions and mechanical considerations, that no matter what the material of the suspension is, a thin flat strip has very great advantages over a round wire. He comes to the following conclusions: In two galvanometers, in which the length of the suspensions is the same, in one of which a round suspension wire .01 inch in diameter is used, and in the other a strip .02802 inch broad and .002802 inch thick (the cross sections of the strip and wire being equal), that with coils of the same shape and volume the same current density will produce nearly five times as large a deflection on an instrument with a strip as on an instrument with a round wire. For the same deflection of the coil the greatest stress in the material of the strip will be not much more than half that in the material of the wire, therefore the liability to zero error will be much less with the strip. For the same rise of temperature the strip can carry 41 per cent. more current, a result of considerable importance when relatively large currents are to be sent through the galvanometer. The cooling surface per unit length of the strip will be nearly twice that of the wire.

He next compares a round wire with a strip of such breadth that the same couple will produce the same twist for the same length of suspension. From this he finds the following: with coils of the same shape and volume the same current density will produce equal deflections with the two instruments; the maximum stress in the strip will be only a little more than half that in the wire for the same deflection; the cross section of the strip will be more than four times as great as that of the wire; the cooling surface per unit length will be nine times as great as with the wire. It will be seen, therefore, that in addition to there being much less zero error with a strip than with a wire, the resistance of the strip will be less than one-quarter of that of the wire for the same length; hence, for the same rise of temperatures, a strip will carry more than six times the current, for in addition to having less than one-quarter of

the resistance it has nine times as much cooling surface as the round wire of the same length.

He then describes an ingenious form of scale used by him. It consists of a horizontal hexagonal roller having ruled on its surfaces six different scales for use with the same instrument. Each face of the hexagon is part of a horizontal circle whose radius is equal to the distance between the scale and the mirror of the instrument. The roller is on bearings so that it may be turned to bring any one of the scales opposite the instrument. Attached to the end of the roller is a brass disc with six notches in it and the roller is turned until a spring notch engages in one of the six notches which holds it. The six scales are graduated respectively from 0 to 10 ampères, 0 to 50, 0 to 100, etc. The act of turning the roller from one position to the other automatically introduces resistance in series with the galvanometer so as to reduce the constant to that corresponding to the scale in use. Hence in whatever one of the six positions the roller may be placed the operator may be quite sure that the readings of the scale and the resistance in series with the galvanometer are in accord.

It was found that if a strip is used instead of a wire there is not much chance of the sensibility of the instrument changing. If a change does occur, however, they correct it with a magnetic shunt on the instrument itself, which is operated by a small screw, the head of which is detached from the instrument to prevent any accidental turning of the screw. This instrument and its magnetic shunt is shown in Fig. 1.

Best Shape of the Coil.—In discussing the best shape of a coil he refers to the paper read by Mr. Mather, in which the author shows that for a given time of oscillation of the coil for a given current density the best effect was obtained by winding the coil so that its cross section at right angles to the axis of rotation consisted of two circles having a common tangent at right angles to the axis of rotation. He showed also that the ordinary methods of winding these coils necessitated for a given current density either that the

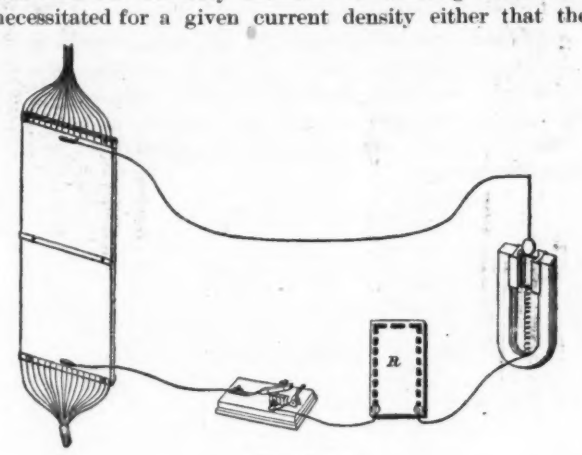


FIG. 3.

periodic time be twice as great as it need be, or that the deflection be only half as great as it might be. Prof. Ayrton concludes that the proper method of procedure is as follows: Having decided on the length and gauge of wire that is to be used in winding the coil, construct the coil as nearly as possible to the theoretically best shape as illustrated in Mr. Mather's paper; next, select a strip of phosphor-bronze of such a breadth and thickness as will be of sufficient longitudinal strength to carry the coil without risk of breaking, and as will cause the coil to have the desired periodic time of vibration; then in a given magnetic field having a given current, a greater deflection will be obtained with this coil than with any other wound with the same length and gauge of wire and suspended so as to have the same time of vibration.

Fig. 2 shows a Pitkin galvanometer made with a coil of this shape in which there is no iron core. The magnetic field in this modification of the d'Arsonval galvanometer is produced by a number of thin horizontal circular magnets instead of by a few vertical ones as in the other figure. The strength of the field in the Pitkin form, in spite of the greater air space caused by the absence of the stationary iron core and the magnets being smaller and lighter, is about 50 per cent. greater than in the other kind.

The shuttle shaped coil is wound with platinoid wire, and has a resistance of 13.5 ohms; the top and bottom suspension together have a resistance of 3.5 ohms, making a total of 17. The periodic time is 2.6 seconds, and one-tenth of a milliampère produces a deflection of 142 scale divisions when the distance of the scale from the mirror is equal to 2,000 scale divisions. In order to compare this with other galvanometers he states that if the periodic time of this coil be increased to 10 seconds and the coil be wound with such a gauge of copper wire that its resistance for the same volume would be one ohm, he finds that one microampère would produce a deflection of 28 divisions. This is larger than with any other d'Arsonval galvanometer of anything like the same size. The one coming next to it produces a deflection of 26 scale divisions.

In this Pitkin form six-sevenths of the weight of the coiled bobbin is due to the copper bobbin on which the coil has been wound, this bobbin having been made of relatively massive character in order to obtain suitable magnetic friction or deadbeat quality. Apart from the special shape of the coil shown in the figure, this method of construction has the great convenience that the coil, with its top and bottom supports, can be at once bodily withdrawn by sliding the framework *F F* out of the tube that supports it in position.

He next discusses what material is best suited for the coil. Some makers wind the coil with copper wire. In cases where these instruments are used for measuring

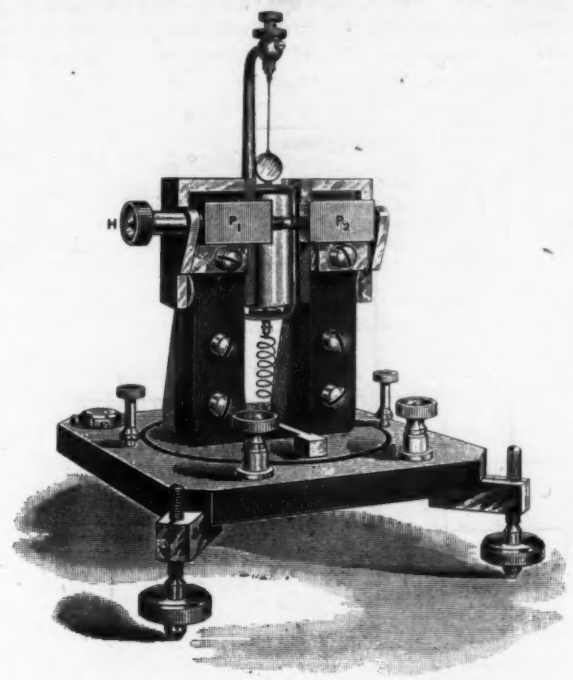


FIG. 1.—D'ARSONVAL GALVANOMETER WITH MAGNETIC SHUNT, CURVED SOFT IRON POLE PIECES, AND SUSPENDED FREELY AT THE BOTTOM, SO THAT THE CENTRE OF GRAVITY OF THE COIL IS IN THE AXIS OF SUSPENSION.

large currents and therefore shunted by a low resistance sheet of platinoid, he thinks it a great mistake to wind the coils with copper, because the readings then require a correction to be made for the changes of resistance of the copper and the platinoid corresponding to variations of temperature in the room, apart from the correction necessitated by the rise of temperature due to the current itself. If the coil is made of platinoid wire there is no necessity for making a correction for the variation of temperature in the room. He states that if no alterations whatever were made in the platinoid sheet used to convey the main current and if the 129-ohm copper coil were replaced by a 10-ohm platinoid coil of the same size (which would be, of course, much cheaper to make) the deflection for any given current passing through the sheet would be increased by 25 per cent. and the temperature coefficient reduced to one-eighteenth of its value for the copper coil. The rate of production of heat in the galvanometer would then be increased for the same current passing through the sheet, but calculation shows that even with this increased rate of production of heat the temperature of the coil would not be raised by one degree centigrade in several hours, even if the maximum current of 1,100 ampères were kept flowing continuously through the sheet, and even if it is assumed that there is no loss of heat whatever from the coil either by radiation, convection or conduction. If in addition the suspension of platinoid wire be also replaced by one made of a phosphor-bronze strip of such dimensions that while it offers the same mechanical resistance to being

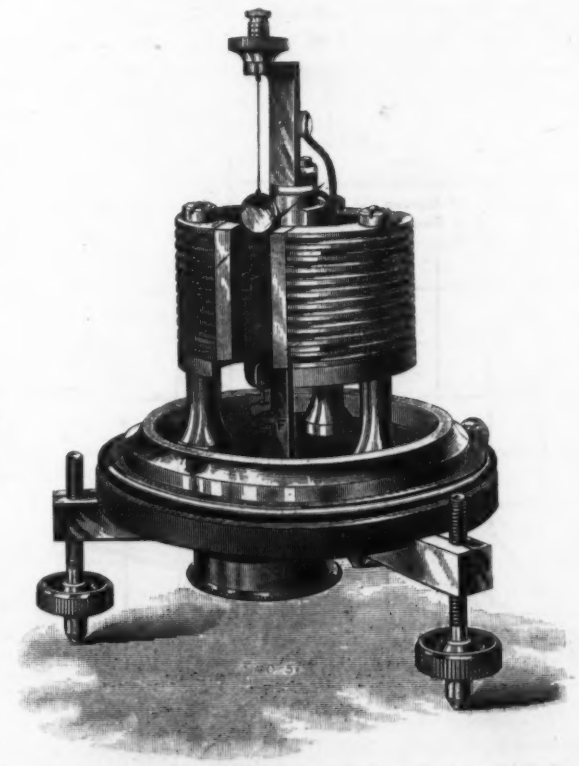


FIG. 2.—D'ARSONVAL GALVANOMETER WITH NARROW COIL AND WITHOUT ANY IRON CORE.

twisted it offers a much less resistance to the current, the sensibility of the 10-ohm platinoid galvanometer will be much greater than that just given.

Calibration.—He next discusses the methods of calibrating such an instrument. The general arrangement of the instrument is shown in Fig. 3. It will be seen that the galvanometer itself is shunted by a large platinoid sheet through which the main current passes. By knowing the constant of the galvanometer and the resistance of the platinoid sheet, the shunting power can be calculated. To enable this resistance to be measured, the sheet was made of five strips which were all made alike and can be joined up either in series or in parallel. They are measured when joined up in series, and are used joined in multiple arc, when the resistance is assumed to be one twenty-fifth of that measured when they are in series. He points out the errors that are caused by the varying resistance in the mercury cups, showing in one case in which it was measured what a difference it made when the mercury contacts were freshly amalgamated and fresh mercury was put into the cups. After discussing these features, he concludes that the best method is as follows:

Solder a wire to each end of the sheet, as seen in Fig. 3; insert some convenient resistance in the galvanometer circuit, the ends of which are attached to the two wires soldered to the ends of the sheet; then observe the deflection of the galvanometer when a known large current is sent through the sheet. Use no mercury cups, bridge pieces, screws, nor anything of a variable character in the platinoid sheet; and, further, it may be well to spread out the wires conveying the main current and solder them to different parts of the edge of the sheet, as seen in Fig. 1, so as to cause the lines of flow of the current in the sheet to be as nearly as possible the same for all currents. To measure this current he employs a Thomson balance, and this, he thinks, would be quite an accurate enough standard for any commercial purpose.

In his laboratory he goes a step further and periodically calibrates the balance by the copper deposit method and states that he is beginning to get successive determinations of the constants to agree to .06 per cent.

He concludes his paper by suggesting the following ar-

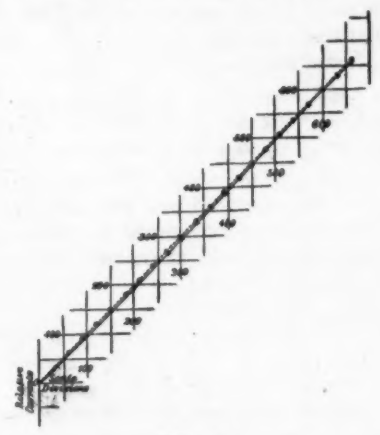


FIG. 4.

rangements as the best for measuring from 5 ampères to 1,100 ampères to an accuracy of one-fifth of one per cent. as calculated by his associate, Mr. Mather. He prefers using two different platinoid sheets, one of five inches by five inches to be used in measuring currents from 5 to 110 ampères and one of fifteen inches by fifteen inches for currents from 50 to 11,000 ampères, the two ranges well overlapping each other for convenience of comparison. He recommends using a 10-ohm platinoid coil on the galvanometer. The advantages to be gained are as follows: No temperature coefficient will be required to be used either for changes in the temperature of the room or for the heating of the platinoid sheet, even by the passage of the largest currents. The maximum resistance to be inserted in series with the galvanometer when the largest current is being measured would be 60 ohms; the total watts expended on the platinoid sheet when the maximum current is being measured would be 40 watts, and that expended in the small sheet would be 4 watts. The thickness of the large platinoid sheet would be .40 inch, that of the small one .04 inch. The resistance of the large one would be .000033, that of the small one .000333 ohm.

The amount of energy consumed in the instrument is of little importance in testing dynamos where all the power given off is converted into heat, but would be of the highest importance when it is desired to measure the current without wasting power, as, for example, when testing the power and efficiency of a coupled dynamo and motor, etc.

Regarding the consistency of some of the instruments used by Prof. Ayrton he finds that two calibrations made 15 months apart were both 613.8 ohms, this being the resistance to be put in series so that 120 ampères through the platinoid strip gives a deflection of 600 divisions.

He arranges his scales so as to have the zero point at one end, and by proper proportioning he succeeded in obtaining a perfectly straight line proportion, which is shown in Fig. 4. The continuous line in this figure shows how the deflection varied with the current before the coil was suspended freely at the bottom and before the curved pole pieces were added, the difference of the deflections from being directly proportional to the current amounted to 2 per cent. in the middle of the scale and to 3 per cent. with some other galvanometers. The dotted line shows the calibration after the changes have been made, and it is to be noticed that this dotted line is absolutely straight. This figure also illustrates the fact that there is no necessity to

use a large sheet of square paper merely for recording such a calibration. Strips cut diagonally at an angle of 45 degrees from a continuous roll of paper are not only more convenient to use and keep, but when a number of calibration curves for different instruments have to be drawn, the total amount of section paper used up in this way is, of course, far less than if a whole rectangular sheet be devoted to each instrument.

On the Relation Between Rise of Temperature and Current in Electric Conductors.—II.

BY F. L. O. WADSWORTH.

The experiments on conductor No. IV. are omitted, because the character of the curve is so different from the uniform character of the others that it seems quite possible that the determinations were affected by some experimental error. Nos. III. and VI. were omitted because they refer to the same strip as VII. and would, it is evident from inspection, give the same value for θ, since the convexity is very nearly the same.

In Table II. (*A*) are given the values taken directly from the curves of Fig. 6 and in (*B*) the values of H for each conductor, showing the dependence of H upon the surface.

TABLE II.

	Loss of heat—watts per linear cm. per sec. (*A*).				Loss—calories per sq. cm. per sec. *H*. (*B*).			
	VII.	I.	II.	V.	VII.	I.	II.	V.
10°	.040	.023	.020	.012	.00188	.00515	.00544	.00617
20°	.085	.048	.040	.024	.0040	.01075	.01088	.01234
30°	.130	.072	.061	.037	.00611	.01613	.01659	.01902
40°	.178	.097	.082	.050	.00836	.02173	.02250	.02570
50°	.230	.125	.105	.066	.01081	.02800	.02856	.03392
60°	.285	.153	.128	.081	.01340	.03427	.03482	.04163
70°	.337	.183	.153	.099	.01584	.04099	.04162	.05089
80°	.392	.213	.179	.117	.01842	.04771	.04869	.06014
90°	.450	.243	.207	.135	.02115	.05443	.05630	.06939
100°	.510	.275	.235	.150	.02397	.06160	.06392	.07710

Each curve gave, therefore, ten observation equations from which the most probable values of A and θ were determined by the same process as that already indicated in the case of McFarlane's experiments. . . .

The values so found were as follows:

For VII. $\theta_{VII} = 1.103$. $\log A'_{VII} = \bar{1}.1607$. $A_{VII} = .0001448$
" I. $\theta_{I} = 1.075$. $\log A'_{I} = \bar{1}.6289$. $A_{I} = .0004256$
" II. $\theta_{II} = 1.068$. $\log A'_{II} = \bar{1}.6521$. $A_{II} = .0004488$
" V. $\theta_{V} = 1.111$. $\log A'_{V} = \bar{1}.6536$. $A_{V} = .0004504$

A comparison of the observed and computed values is given in Table III., and a comparison of the curves plotted from the formula (dotted) with those of observation, in Fig. 2.

TABLE III.

t in C°	VII.		I.		II.		V.	
	H obs.	*H* cmp	*H* obs.	*H* cmp	*H* obs.	*H* cmp	*H* obs.	*H* cmp
10°	.00188	.00184	.0051	.0051	.0054	.0053	.0062	.0058
20°	.0040	.0039	.0107	.0107	.0109	.0110	.0123	.0126
30°	.0061	.0062	.0161	.0165	.0165	.0170	.0190	.0197
40°	.0084	.0085	.0217	.0224	.0225	.0231	.0250	.0271
50°	.0108	.0108	.0280	.0285	.0286	.0293	.0339	.0348
60°	.0134	.0132	.0343	.0347	.0348	.0356	.0416	.0426
70°	.0158	.0157	.0410	.0410	.0416	.0419	.0509	.0505
80°	.0184	.0182	.0477	.0473	.0487	.0484	.0601	.0586
90°	.0212	.0207	.0544	.0537	.0563	.0548	.0691	.0668
100°	.0240	.0233	.0616	.0601	.0639	.0614	.0771	.0751

The correspondence is not as good as in the case of McFarlane's experiments, but is still within the errors of experiment. Finally, if we take the general law of cooling as proposed by Dulong and Petit, and determine the parabolic curve, which corresponds to it most closely, we shall find a value of θ very close to those already determined. The general form of the empirical equation proposed by the above experimenters is

$$h = C\,[1.0077^t - 1] + C_1\, t^{1.23}.*$$

Instead of writing for the convection term $C\ t^{1.23}$, it will probably be better, as Kennelly suggests, to write $C_1'\ t$. In any case, for temperatures less than 100°, the difference will not be great.

The equation may be put in the form:

$$h = C\left[(1.0077_t - 1) + \frac{C_1'}{C}\,t,\right]$$

If we assume this to be represented by the form already used, $h \cong A\,t^{\theta}$, we have

$$h = C\left[(1.0077^t - 1) + \frac{C_1'}{C}\,t,\right] \cong A\,t^{\theta}$$

$$\text{or} \qquad (1.0077^t - 1) + \frac{C_1'}{C}\,t \;C\,\frac{A}{C}\,t^{\theta}.$$

Taking logarithms of both sides,

$$\log\left[(1.0077^t - 1) + \frac{C_1'}{C}\,t\right] = \log\frac{A}{C} + \theta \log. t:$$

which equation furnishes for different values of t a number of equations from which to determine $\frac{A}{C}$ and θ.

In order to complete the value of the left hand member we require to know the value of the ratio $\frac{C_1'}{C}$. An examination of Dulong and Petit's results† shows that for the thermometer bulb which they used this ratio varied from .0019 to .0041, according to the temperature T of the surrounding air.

In the case of a series of wires of different sizes the variation of the ratio is very much greater, being, according to Kennelly's results, from .0162 for a blackened wire 1 centimetre in diameter to .00081 for a bright wire, 0.1 centimetre in diameter.

If we take two values of this ratio near the extremes, viz., .01 and .001, and compute the value of the expression in brackets, we shall find for it the values given in Table

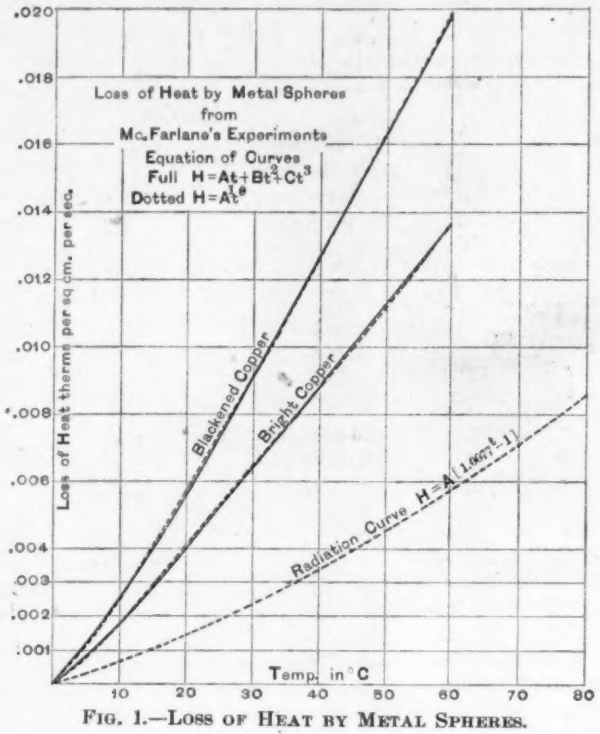


FIG. 1.—LOSS OF HEAT BY METAL SPHERES.

IV., columns (*a*) and (*c*). Then using these values for the determination of $\frac{A}{C}$ and θ as before we find

For $\frac{C_1'}{C} = .01$. $\theta = 1.097$. $\log\left(10\,\frac{A}{C}\right) = \bar{1}.1310$.

$\therefore \frac{A}{C} = .01352 +$

For $\frac{C_1'}{C} = .001$. $\theta = 1.139$. $\log\left(100\,\frac{A}{C}\right) = \bar{1}.7937$

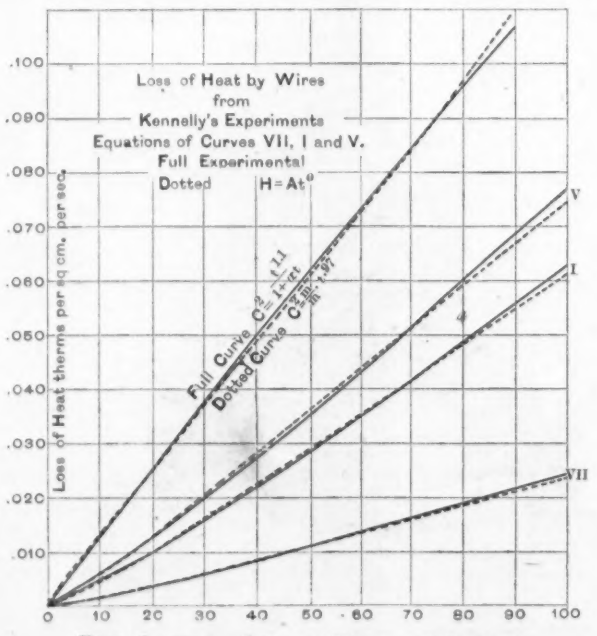
$\therefore \frac{A}{C}$ .006219.

Columns (*b*) and (*d*) give the values of $\frac{h}{C}$, as computed from these values of θ and $\frac{A}{C}$. As before the agreement s very satisfactory.

TABLE IV.

t.	Ratio .01.		Ratio .001.	
	$\frac{h}{C}$ (*a*).	$\frac{h}{C}$ cmp. (*b*).	$\frac{h}{C}$ (*c*).	$\frac{h}{C}$ comp. (*d*).
10°	.179	.170	.0897	.0857
20°	.366	.365	.186	.189
30°	.559	.57	.289	.299
40°	.759	.77	.399	.415
50°	.968	.99	.518	.535
60°	1.184	1.21	.644	.659
70°	1.411	1.43	.781	.785
80°	1.647	1.65	.927	915
90°	1.894	1.88	1.084	1.045
100°	2.153	2.12	1.253	1.181

It will be remembered that the value of θ changes slightly with a change in the diameter of the wires, but that the



FIGS. 2 AND 3.—LOSS OF HEAT BY WIRES.*

change is very small, less than 4 per cent. for a charge of 1,000 per cent. in D, so that for the present it may be neglected.

The general conclusion to be drawn from these results is that up to 100 degrees C. the relation between H and t in the case of wires, flat strips and spheres alike can be very closely represented by the formula $E = At^{\theta}$ in which θ remains very nearly constant for all cases [the mean of the 8 values found is 1.101, with a mean variation of only .016, about 1 per cent.] and A changes with the nature of the body.

In the case of wires carrying current we can now at once find the relation between C and t.

For $H = C^2\,R\,B$, where B is a constant depending on the form and size of the conductor, and R is the specific resistance of the material of which the conductor is composed at the temperature $t + T$.

$$\therefore R = R_0\,[1 + \alpha\,(t + T) = R_0\,[1 + \frac{\alpha}{1 + \alpha\,T}\,t].$$

(T = temperature of surrounding air.)

We have therefore . . . $C^2\,R_0\,[1 + \alpha' t] = At^{1.1}$

$$C^2 = \frac{A}{R_0} \qquad \frac{t^{1.10}}{1 + \alpha' t}$$

or if $\frac{A}{R_0} = m$, a constant for any particular conductor

$$C = \sqrt{m}\,\sqrt{\frac{t^{1.1}}{1 + \alpha' t}} \quad \text{the relation desired—(1)}$$

(1) might be used as it stands for the purpose of comparison with the results of experiment, but it will be more convenient for computation to put it in the usual parabolic form already used, viz., $C = A\,t^{\theta}$

To do this we put $C^2 = m\,\frac{t^{1.1}}{1 + \alpha' t} \cong nt^{\theta}$

Then $\frac{t^{1.1}}{1 + \alpha' t} \cong \frac{n}{m}\,t^{\theta}$.

and $\log\left[\frac{t^{1.1}}{1 + \alpha' t}\right] \cong \log\frac{n}{m} + \theta \log t.$

To calculate this we must know the value of $\alpha' = \frac{\alpha}{1 + \alpha T}$

Evidently this will be a maximum for $T = 0$ . . but we require particularly to know the effect upon θ due to a change in T.

This effect will not be large in any case, because α itself is small. [for copper $\alpha = .00388$]; it will be sufficient then for the present purpose to compute θ for two values of T widely different and interpolate for intermediate values.

Forming ten observation equations and reducing we find the normal equations.

$$\left.\begin{aligned} 10 \log\frac{n}{m} + 16.56\,\theta &= 17.396 \\ 16.56 \log\frac{n}{m} + 28.33\,\theta &= 29.692 \end{aligned}\right\} \text{for } T = 0$$

and

$$\left.\begin{aligned} 10 \log\frac{n}{m} + 16.56\,\theta &= 17.515 \\ 16.56 \log\frac{n}{m} + 28.33\,\theta &= 29.906 \end{aligned}\right\} \text{for } T = 50°\text{ C.}$$

whence $\theta = .97$ and $\log\frac{n}{m} = .1338$ for $T = 0$

$\theta = .988$ and $\log\frac{n}{m} = .1154$ for $T = 50°$.

A comparison of the values obtained from the two formulæ is shown in Table V., columns (*a*) (*b*) (*c*) (*d*).

TABLE V.

t in °C	$T = 0$ $\alpha' = .00388$		$T = 50°$ $\alpha' = .00325$		$T = 0$	
	$\frac{t^{1.1}}{1+\alpha' t}$ (*a*)	$\frac{n}{m}\,t^{.97}$ (*b*)	$\frac{t^{1.1}}{1+\alpha' t}$ (*c*)	$\frac{n}{m}\,t^{.988}$ (*d*)	$\frac{t}{1+\alpha t}$ (*e*)	$\frac{n'}{m'}\,t^{.867}$ (*f*)
10°	12.1	12 7	12.2	12.7	9.63	10.1
20°	25.0	24.9	25.3	25.2	18.6	18.5
30°	37.7	36.9	38.4	37.6	26.9	26.2
40°	50.1	48.7	51.2	49 9	34.6	33.7
50°	61.9	60.5	63.6	62.2	41.9	40.8
60°	73.3	72.2	75.6	74 5	48.7	47.8
70°	84.1	83.8	87.2	86.8	55.1	54.7
80°	94.6	95.4	98.4	99.0	61.1	61.4
90°	104.8	107.0	109.2	111.0	66.7	67.9
100°	114.3	118.5	119.6	123.4	72.1	74.5

We have then finally to this close degree of approximation $C^2 = m\,t^{.97}$ [when $T = 0$] . . or $C = \sqrt{m}\,t^{.485}$ (2).

It will be interesting to compare this result with one which can be obtained from theoretical considerations.

If we consider with Forbes that the emissivity of any conductor is directly proportional to its excess of temperature over that of the air and surrounding bodies (a supposition which for any particular body is nearly true up to temperature excesses of 100 degrees C., as already shown) we obtain the following formulæ:*

$$C^2 = D_1^2\,t\,\frac{\pi^2\,E}{4\,R \times .24} \quad \text{for bare copper wire}$$

and $C^2 = D_1^2\,t\,\frac{\pi^2\,k}{.48\,R} \times \frac{3\,D_2}{10 + 3\,D_2 \log\frac{D_2}{D_1}}$ for insulated wires where

C = current in ampères.
D_1 = diameter of wire in cm.
D_2 = outer diameter of insulated wire in cm.
E = coefficient of emissivity.
k = heat conductivity of insulator.
R = specific electrical resistance at temperature $t + T$.
t = excess of temperature of wire over air in degrees C.

* It is now well known that the terms which express radiation and convection are individually wrong but the sum of the two expresses very closely the total loss of heat from the bodies used in D. and P. experiments.

† *Annales de Chemie et de Physique*, vol. VII., 1817.

* This gure was incorrectly given as Fig. 1 in section I. of this article.

* *Journal of the Society of Telegraph Engineers*, vol. XIII., p. 232 *et seq.*

Therefore, for any particular conductor we have

$$C^{\theta} = B\frac{t}{R}$$

where B is a constant independent of C and t.

But as before, $R = R_0\,[1 + \alpha(t + T)] = R_0'\,(1 + \alpha'\,t)$

$$\therefore C^{\theta} = m_1\frac{t}{1 + \alpha' t}$$

If, as before, we assume $C = n_1\,t^{\theta}$ and determine $\frac{n_1}{m_1}$ and θ as before we shall find $\theta_1 = .867$. $\log\frac{n_1}{m_1} = .1381$ for $T = 0$.

The comparison of values is given in columns (*e*) and (*f*) Table V. From the theoretical formula we have for the relation between C and t; $C = \sqrt{m_1}\ t^{.433}$ (3), a curve not very different in curvature from that already deduced from the data of experiment. It now remains to compare the curves represented by these equations with those obtained by experiment. Four of the experimental curves for wires suspended overhead in the open air and five of those for wires incased in wooden moldings were selected (the selection being so made that the conditions of comparison were made as severe as possible, some of the wires being bare, some insulated with white cotton and some with a black braided insulation of different thickness for different wires) and the constants $\sqrt{m}$ and $\sqrt{m_1}$ determined for each.

The data for the wires and the value of the constants found for them are as follows:

(1) [No. II., Fig. 8] No. 12 B. W. G. bare overhead out of doors—log $\sqrt{m} = 1.170$, log $\sqrt{m_1} = 1.250$.

(2) [No. IV., Fig. 8] No. 8 B. W. G. bare overhead out of doors—log $\sqrt{m} = 1.315$, log $\sqrt{m_1} = 1.397$.

(3) [No. VI., Fig. 8] No. 8 B. W. G. black covered, out of doors—log $\sqrt{m} = 1.375$, log $\sqrt{m_1} = 1.457$.

(4) [No. VIII., Fig. 8] No. 6 B. W. G. bare overhead out of doors—log $\sqrt{m} = 1.512$, log $\sqrt{m_1} = 1.591$.

(5) [No. VI. Fig. 4] No. 18 B. W. G. black covered, in molding—log $\sqrt{m} = 0.513$, log $\sqrt{m_1} = 0.596$.

(6) [No. IX., Fig. 4] No. 14 B. W. G. white double cotton covered in molding—log $\sqrt{m} = 0.735$, log $\sqrt{m_1} = 0.817$.

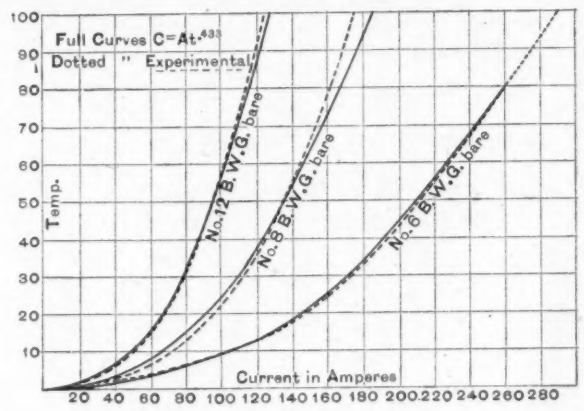


FIG. 4.—LOSS OF HEAT BY WIRES.

(7) [No. XI., Fig. 4] No. 12 B. W. G. black covered, in molding—log $\sqrt{m} = 0.937$, log $\sqrt{m_1} = 1.021$.

(8) [No. XIV., Fig. 4] No. 6 B. W. G. bare, in molding—log $\sqrt{m} = 1.146$, log $\sqrt{m_1} = 1.228$.

(9) [No. XIX., Fig. 4] No. 2 B. W. G. black braided, in molding—log $\sqrt{m} = 1.444$, log $\sqrt{m_1} = 1.526$.

The numbers in brackets refer to the numbers used on Kennelly's charts, from which the values of C for given values t were taken and tabulated as experimental values.

The results of the comparisons are as follows:

TABLE VI.

	No. (1).			No. (2).			No. (3).		
t in ° C.	$\sqrt{m}$, $t^{.485}$	Exp. value.	$\sqrt{m}$, $t^{.433}$	$\sqrt{m}$, $t^{.485}$	Exp. value.	$\sqrt{m}$, $t^{.433}$	$\sqrt{m}$, $t^{.485}$	Exp. value.	$\sqrt{m}$, $t^{.433}$
10°	45.2	51.0	48.2	63.1	70.0	67.7	72.5	80.0	77.7
20°	63.3	66.0	65.2	88.3	94 0	91.5	102.0	107.0	105.0
40°	88.5	88.0	88.0	123.6	125.0	124.3	142.0	143.0	141.6
60°	107.6	104.0	105.0	150.0	146.0	147.0	173.0	169.0	169.0
80°	124.0	117.0	118.8	173.0	162.0	167.0	198.6	188.0	194.0
100°	138.0	128.0	130.8	192.6	176.0	183.6	221.0	204.	211.0
	No. (4.)			No. (5).			No. (6)		
10°	99.4	102	105	9.9	9.2	10.7	16.6	15.5	17.8
20°	139.0	145	143	13.9	14.0	14.5	23.2	22.5	24.0
40°	194.5	195	193	19.5	20.0	19.5	32.5	32.5	32.5
60°	226.0	231	230	23.7	24.2	23 3	39.5	40.3	38.7
80°	272.0	261	260.6	27.3	27.7	26.4	45.5	47.0	43.9
100°	.....	.....	.....	30.4	31.0	29.0	50.7	53.0	48.3
	No. (7).			No. (8).			No. (9).		
10°	26.4	26.0	28.4	42.8	39.0	45.8	84.9	84.0	91.0
20°	37.0	37.5	38.5	59.8	58.0	61.9	119.0	116.0	123.0
40°	51.8	51.5	51.9	83.7	85.0	83.6	166.0	163.0	166.0
60°	63.0	63.3	62.0	102.0	105.0	99.8	202.0	201.0	198.0
80°	72.5	74.0	70.2	117.0	121.0	113.0	233.0	237.0	225.0
100°	80.8	84.0	73.0	131.0	137.0	125.0	260.0	270.0	247.0

The curves experimental and calculated for (1), (2) and (4) are given in Fig. IV. The agreement for the others is equally good, in some cases better, as a reference to the table will show.

In the case of the first four wires which were suspended out of doors, formula (3), deduced from Forbes' theoretical equation, agrees more closely with the experimental results than (2). The greatest difference between the experimental value and that calculated from (3) is about 5 per cent., and the greatest difference between this value and that from (2) less than 10 per cent., the average difference being 2 to 4 per cent.

These differences, although still quite large, are much smaller than the experimental errors which in the case of the wires considered were sometimes as large as 10 or 15 per cent. The agreement is moreover much better, in both cases, than that between the experimental values and the values deduced from the formula proposed by Kennelly, which in one case at least gives a result over 20 per cent. too small.

The reason why formula (3) suits this case better than (2) is not difficult to find. In still air the energy required to set up convective currents is entirely supplied by the wire itself, and the loss of heat due to these currents will be proportional to their energy, that is, to the temperature of the wire. Out of doors the loss of heat by convective cooling is assisted by natural currents which, not depending on the temperature of the wire, have an effect which probably increases less rapidly than the rise of temperature. The result is that the total loss of heat due to the natural and convective currents falls behind the rise in temperature, giving a curve convex toward the axis of temperatures. This conclusion is supported by an examination of the curves representing the loss of heat by convection out of doors [Fig. 9, Kennelly's article], all of which are of this character (convex toward axis of t).

It follows then that the total loss of heat at any temperature, the quantity H, being made up of two terms, one of which is proportional to t^{θ} where $\theta > 1$ (radiation), and the other proportional to t^{θ} where $\theta < 1$ (convection), is very nearly proportional to the first power of t; precisely the assumption made in the deduction of (3).

In the latter five cases where the conditions more closely approximate those for which the loss of heat follows the experimental law of Dulong and Petit, and McFarlane, we should expect formula (2) to correspond most closely, and this indeed we find to be the case, the maximum differences between the observed and calculated values not exceeding 5 per cent., except for very small values of t, and the mean difference being considerably less.

It will be noticed also that the agreement with the formula is equally good in all cases whether the wire be bare, white cotton covered or black (kerite) covered—a confirmation of the opinion already advanced that the law of relation between current and temperature for any given conductor is independent of the question as to whether that conductor be bare or insulated. The relation *is* affected by the conditions under which the wire is used, but only to a slight extent.

It still remains to determine the general relation between C, D and t. Such a general relation is expressed by Forbes' formula, but it has been shown that for different values of D this formula gives results which differ more than 100 per cent. from those obtained by experiment. Kennelly has given a formula similar to that of Dulong and Petit, which agrees very much more closely with experiment.

This is $C^{\theta} = \dfrac{\pi D^3}{4R(1 + \alpha(t + T)}\,[\pi m D\ C[1.0077^t - 1] + C_1\,t]$

As will be readily seen, however, it is impossible to readily express either D or t as a function of the other two variables, and that even the computation of C is complicated. I have found that the relation can be expressed with a high degree of approximation by a formula similar to that used for the relation between C and t. I am now engaged in a determination of the value of the constants, and hope soon to communicate the results. I hope that I have already shown that the relation between C and t is certainly not linear, and have proposed a formula which is closely approximate to the true relation between them.

If the linear relation, such as is assumed in the diagram referred to at the beginning of this article, is used, the result will be either that the wire will heat excessively when carrying large currents, or will be much larger than necessary for small currents.

The use of a No. 14 wire where, for instance, a No. 18 will answer as well, is certainly bad economy, and a mistake in the reverse direction is no better. In the first case the first cost is rendered excessive, in the second case bad regulation, and consequently a large amount of lamp breakage, is sure to follow, in addition to the waste of a large amount of energy in the wires.

A Curious Electrical Phenomenon.

BY E. F. DIETERICHS.

While experimenting with arc lights recently, a carbon pencil fastened to corks, floating on water in a hydrometer jar, was made use of and during the night and day following the jar and its contents were exposed to a very low temperature, after which it was observed that a singular formation of ice, as shown in the accompanying diagram, had taken place.

The cylinder shaped piece of ice shown in the figure was taken from a glass jar. *A A* represents the copper coated carbon pencil. *B B* are the corks on which the carbon pencil floated. *C C* are the round heads of common pins, inserted in the corks to steady the float against the sides of the jar.

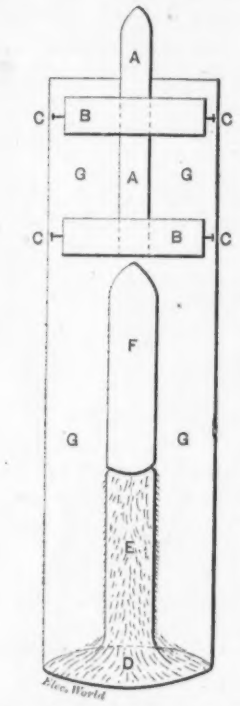
The jar filled with water, with the carbon floating on it, was placed on an iron retort stand, from the upper ring of which another copper coated pencil was suspended, and both carbons were connected by wire with a dynamo. During the experiments, particles of intensely heated carbon fell into the jar and, sinking to the bottom, heated the water somewhat and accumulated as shown at *D*.

After disconnecting the wires the apparatus was left undisturbed and cold weather setting in, the water in the jar was frozen, and a solid cylinder of ice was taken from the jar.

The ice, *G G*, around the float and around the formations, *F F*, in the centre was brilliantly clear, but from the mound of particles of carbon, *D*, on the bottom arose a column of white opaque ice, *E*, dotted all over with small ice needles, and stretching with larger and longer ones, like tentacles, over the little mound of carbon on the bottom. This column of opaque ice was of the same length and shape, but a little larger in circumference, as the remnant of the carbon pencil suspended from the ring of the retort stand. Above this column of ice was an empty space, *F*, also of the same length and shape, and likewise a little larger in circumference, than the carbon pencil, *A A*, on the float.

The accidental breaking of the ice cylinder prevented examination as to hydrogen gas having been contained in this hollow space.

What caused this curious formation, and why had the opaque ice and the hollow space the same length and shape as what had been left of the two carbon pencils after the experiments? Was it the result of the water being charged with electricity from the dynamo while the experiments were going on, or was it the formation of a current between the floating copper-covered carbon and the metallic pins stuck in the corks and the mound of particles of carbon and melted copper on the bottom of the jar? Whatever the cause, it must have possessed considerable force to form the empty space against the pressure of the surrounding water.



A CURIOUS ELECTRICAL PHENOMENON.

Western Enterprise at Creede, Colo.

A remarkable feat in the construction of an electric light plant has been accomplished in the youngest town in the world at the present time, Creede, Colo. Everybody is familiar with the history of this place, which within a short time has jumped into prominence and to-day is alive with all the advantages and disadvantages of a mining town developed in a marvelously short time and to quite an extensive degree by that element of vitality and grit which is most noticeable in Western people. Many have read the announcement which has been made that "Creede, Colo., has electric lights," but few are aware of the phenomenal time occupied in the construction of the plant.

The idea of equipping the plant was conceived at noon, Feb. 1, by John W. Flintham, general manager of the Denver Consolidated Electric Light Company. Before the day was over, the Creede Electric Light and Power Company was organized and incorporated, supplies were ordered and placed aboard a special train of cars at Denver that had been chartered from the Denver & Rio Grande Railway Company, and everything necessary for the complete equipment of a model electric light plant, for arc and incandescent lighting, by midnight of the same day were on their way to the modern mining camp. Creede was in sight Tuesday night, Feb. 2, and by daybreak the following morning a gang of laborers was put to work breaking ground and getting the foundations of the power-house ready. By this time the town was alive with interest in the work and pool sellers were offering odds on the time to be occupied in completing the plant. The work progressed night and day and the electric current was turned on at 11.15 P. M., Saturday, Feb. 6. The actual time occupied in completing the plant, erecting the buildings and placing the machinery in position, was from Feb. 3, 7 A. M., to Feb. 6, 11:15 P. M., less than a week after the machinery was purchased in Denver, over 300 miles away, and this young town was given the latest luxury of civilization. Arc and

incandescent lamps illuminate gorge and mountain side, and the hum of the dynamo recalls the mind of the seeker after riches to an occurrence without a parallel in electrical history.

The magnitude of the undertaking will be understood from the following inventory of the plant: Two boilers, 100 h. p. each; one Armington & Sims high speed engine, 100 h. p.; one pump; one dynamo of 80 arc lights; one 400-incandescent light dynamo and two 50-ft. iron smoke stacks.

Since the house was completed another dynamo of 60-arc light capacity has been added, and the company will increase the capacity for incandescent lamps to 1,000 as quickly as the machinery can be set, and the capacity of the plant will be increased as quickly as there is any demand for more light or power. The value of the plant is said to be from $35,000 to $50,000.

Elements of Practical Electricity.*

BY DR. LOUIS BELL.

Having made yourself thoroughly familiar with ordinary resistance measurements, it would be worth your while to take up some of the special problems in electrical measurements which not infrequently are encountered. In order to do this readily, you must take up the study of your reflecting galvanometer and learn how to vary its sensitiveness and to standardize it.

MEASURING THE RESISTANCE OF A GALVANOMETER.

If you happen to have at hand a testing set such as has already been described, or can conveniently borrow it, you may measure the resistance of your galvanometer precisely as you would that of any other piece of wire. As its resistance is several hundred ohms, when all three coils are in series the proportional coils in the testing set will come into play. If you have not a testing set, and cannot conveniently use a second sensitive galvanometer, the instrument you are measuring can be made itself to serve the purpose. The process of measuring the resistance is a very simple one, being only a modification of the Wheatstone bridge method. Referring to Fig. 36, which gives a diagram of the Wheatstone bridge, to measure your galvanometer resistance you should place the instrument in the arm c instead of at g, placing, however, the key at g, by which to open or close the cross-section of the bridge. If the galvanometer were at g, and the resistance in the arms were proportional, as has been described, it would make no difference whether the key were opened or closed; with the galvanometer in the arm, however, there will be a considerable deflection of the needle. But when the resistances in the other arms of the bridge are properly adjusted, it will make no difference in the magnitude of this deflection whether the key, which has replaced the galvanometer in Fig. 36, be open or closed. As the galvanometer has a rather high resistance, the arms of the bridge should also have a comparatively high resistance, and it is desirable to cut down the current which is applied to the bridge in order that the deflection of the galvanometer needle may not be so great. This can be done in various ways; for one thing, the battery power should be comparatively small, and you may conveniently arrange to apply only a low electromotive force. This can be obtained by the plan, previously described, of making a closed battery circuit through several of your extra resistance coils, and then tapping into this circuit across the terminals of one of these resistances, thereby getting only that fractional part of the electromotive force of the battery that is due to the drop in potential between the terminals of that particular coil. The wires leading from these terminals should be treated in setting up the bridge as if they were ordinary battery wires. The method of procedure in making the measurement is as follows: Put in the galvanometer, the resistance of which you have previously computed roughly from the amount of wire you have wound upon it, so that you may know at once the proper resistance to insert in the variable arm of the bridge. The needle would be deflected. For convenience bring it back to zero by means of the directing magnet of the galvanometer, then complete the operations precisely as in any ordinary bridge measurement. Of course the condition for no change in the galvanometer deflection, whether the cross connection be open or closed, is $b : d :: a : c$, which in this case is the resistance of the galvanometer.

You must be mindful of the fact that you never will reach a point in making this measurement where the spot of light will remain absolutely stationary whether the key is open or closed. The spot of light on the galvanometer scale will always give a slight kick, due to the fact that your resistance coils are wound non-inductively, that is, the wire was doubled before winding so that the current in half the coil is running in one direction and in the other half in the other, while in your galvanometer the current is flowing in the same direction all the time, and is slightly retarded by the fact that the wire is coiled.

You had better try this measurement both with the Wheatstone bridge, temporarily set up, and with your slidemetre bridge, determining the resistance of the galvanometer a number of times and taking the average. If you get a chance to check this by comparison with a testing set all the better.

For use in connection with your galvanometer you will find a shunt of great value. The shunt to a galvanometer is a coil intended to be put in parallel with the galvanometer whenever it is desired to reduce its sensitiveness. It is simply put as a shunt across the terminals of the galvanometer. The current then divides at the binding post, part passing through the shunt and part through the galvanometer. The law according to which it divides you already know if you know the relative resistance of the two. It is customary, as a matter of convenience, so to make a shunt for galvanometer work that exactly one-tenth or one-hundredth, or one one-thousandth of the current shall pass through the galvanometer. A one-tenth shunt is perhaps the most generally used.

MAKING A SHUNT FOR A GALVANOMETER.

You will readily see that to send just one-tenth of the supplied current through the galvanemeter requires that the shunt should have one-ninth of the resistance of the galvanometer. With one-ninth resistance of course nine times the current will pass through, and of the total current one-tenth will pass through the galvanometer and nine-tenths through the shunt. In the same way a shunt for one one-hundredth would have one ninety-ninth of the resistance of the galvanometer, and for one one-thousandth, one nine hundred and ninty-ninth. Having obtained your galvanometer resistance you can proceed at once to make your shunt. This should be wound as any other resistance coil, carefully testing, however, so as to be just one-ninth the resistance of the galvanometer.

A STRIKING DISPLAY OF ELECTRIC LIGHTS ON THE STAGE.

You had better get at this point in your work some German silver resistance wire for making your shunt and miscellaneous resistances. You had better get one pound of No. 30 insulated German silver wire. There will be nearly 3,000 feet in the pound, and its total resistance will be in the neighborhood of 4,500 ohms. As German silver varies very much, you would better cut off say 10 feet and get the exact resistance. Then employ a suitable amount of this for making a shunt for your galvanometer. You will do well to make in addition three 1,000 ohm coils, insulating them very carefully and adjusting them as nicely as your facilities permit. It would be a good plan to make one 500-ohm coil first and then to use it in adjusting the 1,000-ohm coils. You may in addition make two 200-ohm coils and one 100-ohm coil of this same wire. By the help of these you will be able to set up a Wheatstone bridge with high resistance in the arms, which will come into play in case high resistances are to be measured.

MEASURING ELECTROMOTIVE FORCES.

You have already seen in a general way how resistance current and electromotive force are to be measured, but you are now to do a little more accurate and careful work. A standard of electromotive force is very difficult of attainment. About the only reliance is upon standard cells, of which there are several kinds. The electromotive force of the Daniell cell and also of the Latimer Clark standard cells, to which you will here frequently find reference made, has been determined with a great deal of accuracy by delicate and elaborate measurements. The former is the more convenient of the two for ordinary work, although it is somewhat less reliable, inasmuch as the Clark cell is difficult of preparation and cannot be used except with special precaution to avoid polarization.

For your purpose you had better get a small Daniell cell, reserving it exclusively for testing work. One of about a quart capacity is large enough. Use a fresh porous cup in this, and obtain some chemically pure copper sulphate, zinc sulphate and a stick of pure zinc, which should occupy the porous cup. Make up a solution of the pure copper sulphate so that its specific gravity will be 1.1 at the ordinary temperature, say about 65 degrees Fahrenheit; put this away in a stoppered bottle only to be used when wanted. Make up in a similar solution of the zinc sulphate, with a specific gravity of 1.4. These particular densities may be determined by a hydrometer, an instrument you may desire to obtain as it is not expensive. Any druggist possesses it so that he can make up solutions for you.

When you desire to use this standard Daniell cell for measurements of E. M. F. set it up carefully, using your zinc rod inside the porous cup and employing outside a copper cylinder which you have freshly electroplated so that the surface shall be pure. The cell should not be used long else the copper sulphate solution will become depleted, and in order to be anywhere nearly sure of the E. M. F. it must be kept up to density. When it is made the E. M. F. of the cell is 1.07 volts. It should remain set up half an hour or so before closing the circuit upon it in order to let the liquids permeate the porous cup slightly, and should be used only through a rather high resistance. When you are through using it it should be immediately taken down, the liquids poured into their respective bottles and the porous cup soaked out thoroughly with water before being put away to dry.

You will now do well to standardize your galvanometer by reference to this cell. For that purpose place in series with your galvanometer your largest resistance coils—you have at least 4,000 ohms available, and it should all be used—then close the circuit, and having set up your galvanometer very carefully with the scale at a known distance from the needle, close the circuit through your galvanometer and note the deflection produced. If it is too large, that is, half your scale or more, counting from the zero point, you must cut it down by bringing your directing magnet down closer to the scale by using one of your galvanometer coils instead of both, or putting still more resistance into the circuit. If the deflection is too small, only an inch or so, which would hardly be the case, however, raise the directing magnet until it becomes greater. The deflection may conveniently be about 100 or 150 scale divisions, supposing your scale to be divided by millimetre divisions.

You have now determined the deflections produced by a known electromotive force that is 1.07 volts, and you have virtually converted your galvanometer into a voltmeter.

If you take your standard cell and put any other in its place you will get a somewhat different deflection, in amount strictly proportional to the difference of electromotive force, for when working through a very high external resistance that of the battery is negligible compared to it, and the amount of current forced through the external resistance is directly proportional to the electromotive force of the battery; but, as has been already explained, with your reflecting galvanometer your deflections are directly proportional to the currents; hence simple proportion will give you the electromotive force of any battery you may have at hand.

It may interest you from the electromotive force of your standard battery and the known resistance in circuit to figure out the minute amount of current required to produce a deflection of a single division of your galvanometer scale. You will be surprised to find out how enormously sensitive the instrument can be made if you adjust it carefully.

So much for the adjustment of the galvanometer and the simple determination of electromotive force by its aid.

*Continued from THE ELECTRICAL WORLD of Feb. 20, 1892.

A Striking Use of Electric Lights on the Stage.

In the recent production of Faust at the Metropolitan Opera House the fact that electricity has become a very important factor in theatrical performances was emphasized. There have been described at different times in the columns of THE ELECTRICAL WORLD electrical appliances and apparatus of various kinds for adding realism, beauty or rapidity to the arrangement of stage settings, and these same appliances have become as indispensable to the management as the leading performers themselves.

In "Faust," as it was presented at the Metropolitan Opera House, in the second act, where *Mephisto* is left alone in the garden among the flowers, he spreads his arms over the flower beds as he sings, and instantly the garden is all aglow with different colored lights, and the effect of the transformation was beautiful and pleasing in the extreme, and well worth seeing, showing the results that it is possible to attain by the use of electrical features in connection with scenic art. It adds much to the strange sensation that involuntarily seizes one in this part, and is, with the rest of the stage setting, entirely in touch with the weird music.

A Long Distance Power Plant in a Colorado Mine.

The utilization of sources of power remote from the point of application has, during the past two years, received considerable attention from electricians in this and other countries, and repeated experiments have demonstrated the practicability of utilizing power, by the adoption of electrical methods, which would otherwise be wasted, and of its utilization to such advantage that projects may be, and have been, carried out, which, without the application of electricity, would have been impossible. This has been particularly the case in the mining industry. Lodes of metal are frequently found at great altitudes, where, unless some cheap power can be applied at the required spot, they can never repay working. It is not so long ago that a project to generate power for mining purposes at the foot of a mountain and utilize it economically midway, or at the summit, would have been regarded as visionary; but this feat has recently been accomplished in a number of installations and with complete success.

A good example of this, at the present time, is the large plant which has been installed by the Edison General Electric Company at the Virginius group of mines near Ouray, Colo. It is one of the largest, if not the largest, purely mining plant in the world. Every difficulty likely to be met with in work of this nature was encountered in the installation. The pipe line is laid along the side of a rocky cañon. The wires from the power house to the mine are strung partly through dense timber, where they are exposed to damage from falling trees, and partly above timber line, over rocks and snow banks, where the poles and wires are liable to be carried away by snow slides, and where lightning storms are frequent and violent. The line is nearly four miles long. The E. M. F. used is 800 volts. The relative advantages of the ground return and complete metallic circuit are recognized, switches being arranged that either may be employed, the metallic circuit being used at present.

The plant includes a variety of machinery, comprising two pumps, one hoist, one blower and two motors running mills, in fact, almost everything needed except locomotives and drills, and these will probably be added shortly.

The enormous saving that can be effected in many places by the utilization and transmission of water power by means of electricity is strikingly apparent. Coal at the mines costs $18 per ton, and before the installation of this plant was made the cost of the power amounted to nearly $40,000 per annum, which is now saved since the adoption of electric power.

An instance is also afforded of unprofitable mines being rendered profitable by the use of cheaper power, for while some of the mines in this group are sufficiently rich in metal to repay working under the most adverse conditions, there are others of lower grade which would have been shut down in case the electric plant had proved a failure, but with the plant a success will now yield a satisfactory profit.

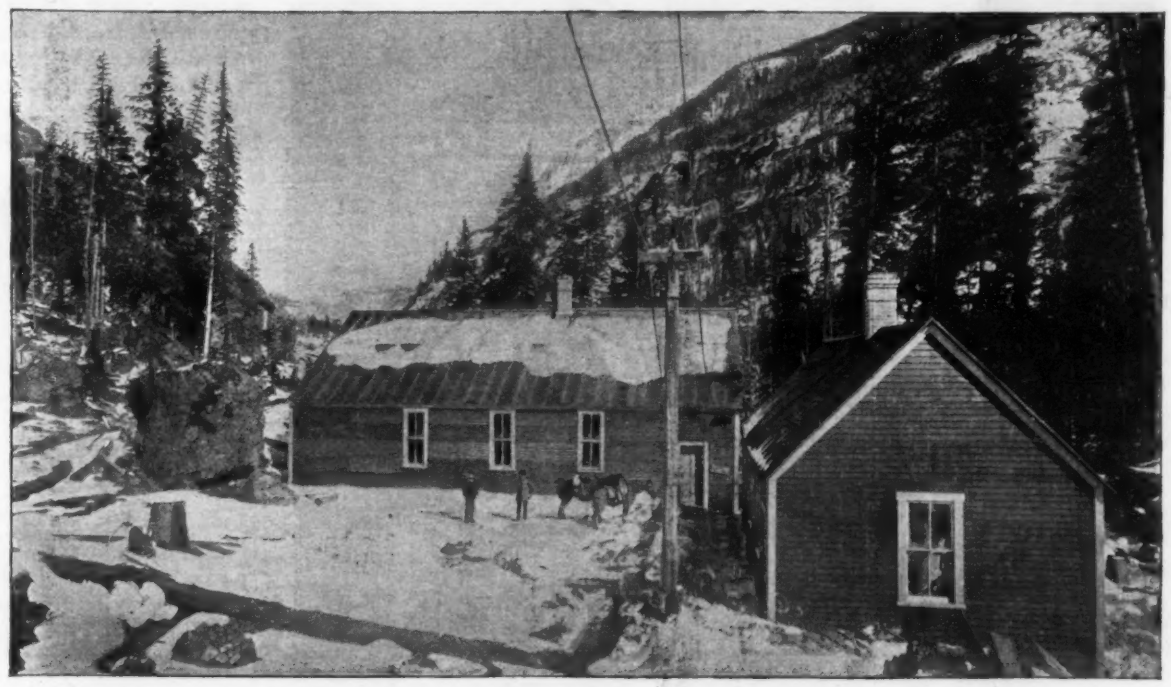


FIG. 2.—POWER HOUSE AT OURAY, COLO., AT AN ALTITUDE OF 9,000 FEET.

FIG. 3.—LINE CONSTRUCTION THROUGH THE TIMBERED SECTION OF THE MOUNTAINS.

The foregoing will give a general idea of the nature of the plant and the difficulties encountered in its installation, but an actual visit to the mine would be necessary to give a correct conception of the real character of the plant, which is undoubtedly one of the most remarkable in existence. Great credit is reflected on the managers of the mine, who possessed the requisite enterprise and sagacity to expend such a large amount of money on apparently a purely speculative experiment, the success of which was regarded as uncertain by even the strongest advocates of electric transmission of power.

If a careful search of the Rocky Mountain region had been made with a view of selecting for the first extensive experimental mining plant a location presenting every conceivable difficulty, which would prove a crucial test to electric power at the very outset, it is very probable that the Virginius mine would have been chosen. The Virginius and neighboring mines, owned by the Caroline Mining Company, are situated near the summit of Mt. Sneffles, in a region of perpetual snow, at an altitude of 12,700 feet above the sea and about 5,000 feet higher than timber line. They are reached by a wagon road, open in the summer but impassable in the winter, when the only route to the mines is by a difficult trail, the lower part of which, known as the "zig-zag," winds up a declivity so precipitous that oftentimes burros with their packs slip from the trail and roll down past several branches of the "zig-zag" before being stopped by a tree or rock. The upper part extends over a rocky plateau above timber line, and along cliffs where the snow is frequently more than 20 feet deep on the level, and where terrific wind and lightning storms are frequent. The lower half of the line from the power house to the foot of the "zig-zag" extends up a deep cañon through a forest of dense timber. The danger of breakage and grounds from falling trees, which are frequently blown down by storms and rest on the wires for some time before they can be removed, is continually present, and the construction of heavy line work over nearly four miles of such ground is an undertaking, the difficulty of which is evident, but which can be fully appreciated only by an actual examination; while the maintenance and operation of the plant under the conditions mentioned present even more serious difficulties. But although these difficulties are exceptionally great, the enormous expense of transporting fuel to the mines rendered the advantages of an electric transmission plant so very striking that the management was induced to make the trial.

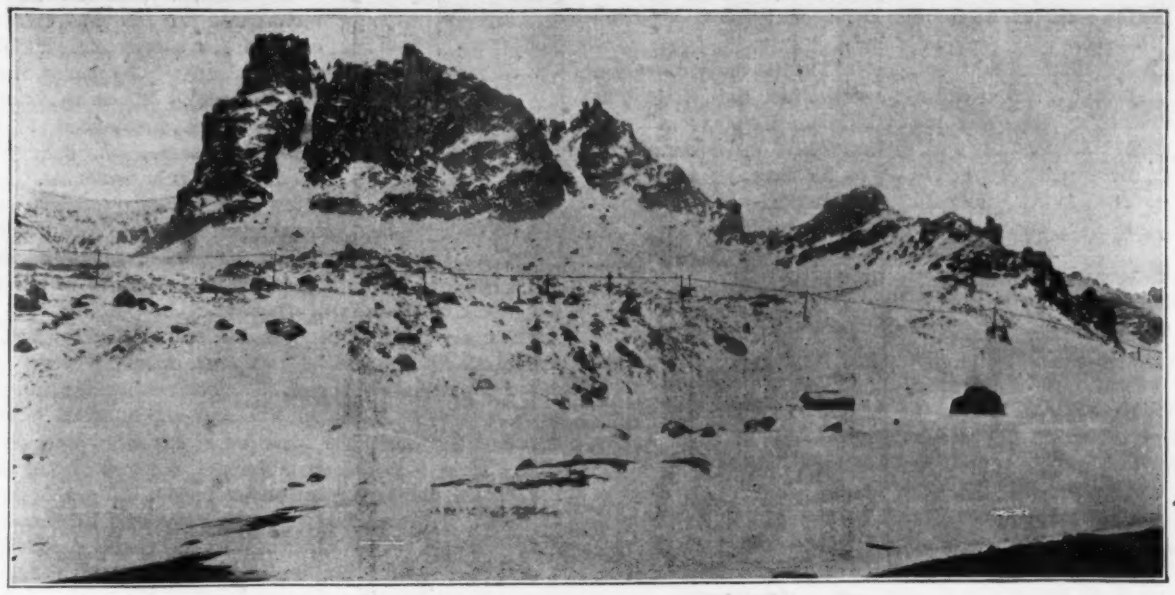


FIG. 1.—LINE CONSTRUCTION OVER A SNOW PLATEAU AT AN ALTITUDE OF 12,500 FEET.

The water power utilized for the plant is in Red Cañon Creek, nearly four miles distant from the mines. The plant consists of a small dam, an iron pipe line extending along the side of the cañon a distance of about 4,000 feet, giving an effective head of 485 feet, and two Pelton wheels, one 5 feet and the other 6 feet in diameter, capable of developing under that head 500 h. p. and 720 h. p. respectively, or a total of 1,220 h. p., the two wheels being connected to separate shafts, so that either wheel may run the entire station.

The electric generating plant comprises at present on 100-k. w. Edison dynamo and two 60-k. w. Edison dynamos, giving a total output of 293 e. h. p. The length of the line, as previously described, is a little over 19,000 feet.

The electric machinery operated at the mines consists at present of two pumps, 60 h. p. and 25 h. p. respectively; one hoist, 25 h. p.; two Edison motors, each of 60 h. p., running concentrators and stamping mills, and a 15 h. p. blower. The large pump, which was erected when the plant was first installed, raises 150 gallons of water 700 feet per minute, and is of the Knowles duplex type. An Edison standard motor is geared to it by a double worm, one right hand and one left hand, working into two spur gears that mesh into each other and operate the pump, the object of the two worms being to neutralize the longitudinal thrust. The smaller pump, which was installed a few months ago, is somewhat similar, the motor, however, being mounted over the pump, with its armature vertical, the weight of the armature counteracting the thrust of the single worm employed.

Both pumps have been working steadily and smoothly for several months and have, it is stated, satisfactorily filled requirements.

The hoist consists of an Edison motor of standard type, but of street car winding, with controlling switch, geared to the drum through the medium of a friction clutch. By means of the controlling switch and clutch the hoist is under more perfect control than a steam hoist.

The motors for the mills and blowers are of the standard type and present no exceptional features.

The most serious troubles have been caused by lightning --electric storms in that section of the country being frequent and very violent. This has formed the subject of particular study, and special lightning arresters have been devised that give excellent protection, and since their adoption little or no trouble has been experienced from this source.

That difficulties were encountered in the early operation of the plant is not surprising, and the fact that these difficulties have been overcome and the entire plant is being operated successfully and satisfactorily under conditions that for severity are not likely to be exceeded anywhere, demonstrates the practicability of electric power for mining and is a guarantee of its success in this field.

Electricity in Mining.

The application of electricity in mining is rapidly becoming more general as its advantages become more apparent and the success of operating plants of the kind is assured. THE ELECTRICAL WORLD in a series of articles in recent issues gave all the latest developments in this rapidly growing branch of electrical industry. Since the publication of the articles referred to a large number of productive mines, and many mines regarded as unproductive, have been equipped with electric mining appliances, and the successful working of the same is a favorable indication of the developments which may be expected in the business during this year. Electricity will be introduced to a large extent in mining this year in Colorado and the Northwest. The successful transmission of powerful currents over long distance circuits is a feature particularly advantageous in many apparently inaccessible mining districts, and the utilization of water power has revived many camps, besides saving thousands of dollars in fuel and other expensive features of mining. In this issue of THE ELECTRICAL WORLD a description is given of an important Colorado plant, in which many of the difficulties met in mining districts apparently have been successfully surmounted by the use of electricity.

FIG. 1.—USE OF LANTERN IN THE OIL REGIONS.

Referring to this subject the Denver *News* in a recent issue had the following: "Since the inception of this movement an order has been received at Denver headquarters for a 300-h. p. plant which will transmit a current over a distance of eight miles at a cost not to exceed $200 per horse power. The Gold King has also contracted for a plant to run a long distance, and after a successful demonstration the company will treble the capacity, raising it to 240 h. p. This is the first instance where the fluid has been carried over 3½ miles. The Aspen Contact mine will run three diamond drills and a couple of ventilating fans, taking their power from a distance.

"The Westinghouse company is now figuring on a plant that will take the current a distance of 15 miles from the water supply to the mine on the other side of the mountain. The plant will be run by a Pelton turbine wheel, and will be put in at a cost not to exceed $5,000. The whole runs from a main generator transmitting the current to a small motor at the mines, and the motion is as regular as the wheels attached to opposite ends of a steel shaft. At Portland, Ore., the water-works system has been inaugurated within the past two weeks by transmitting 15 h. p. 14 miles from the falls of the Willamette for the purpose of lighting the city." Manufacturers of electric mining apparatus report a most gratifying demand for appliances of the kind, and as this new feature in mining operations has passed beyond the experimental stage a more general use of electric mining apparatus may be looked for. The lighting of mines by electricity is a feature not to be lost sight of, as it possesses all of the advantages of safety and utility, and the use of the ittle oil lamps by miners will soon be a thing of the past.

The Distribution of Stored Electricity.

THE operation of phonographs, sewing machines, dental and surgical instruments, fan motors and the like has created a demand for a systematic distribution of electricity by means of storage batteries. When the storage battery was introduced it was claimed by some, who believed in the future of this invention, that in a few years stored electricity would be delivered from door to door as readily as milk. This was regarded as impracticable by many, owing to the weight of the battery and the necessity of frequent recharging.

The many improvements in the storage battery and the increased efficiency of electric motors has, however, rendered this distribution possible. The Storage Battery Supply Company has between five and six hundred batteries distributed throughout New York, Brooklyn and Jersey City. These batteries are recharged at regular intervals as the service demands, continuous power being supplied in all cases. The standard type of battery used for this work is known as S 17, manufactured by the Consolidated Electric Storage Company, for whom the Storage Battery Supply Company is sole agent for New York City.

Nearly 450 of these batteries are required for the operation of phonographs. In addition to this, batteries are supplied for medical, surgical and dental uses, motors for sewing machines and fans, decorative effects, illuminated signs, etc.

The accompanying illustrations show the portable electric lantern manufactured by this company. There is a great demand for a portable safety lantern of this character to be used in places where there is danger of fire or explosion, such as oil wells, gas works and powder mills. The lanterns are being used very extensively by the National Transit Company at their pumping stations throughout the oil regions.

FIG. 2.—PORTABLE STORAGE BATTERY LAMP.

The standard size lantern, as illustrated in Fig. 2, is 6¼ inches high, 4½ inches wide, and 2½ inches deep. The case is made of quartered oak. A specially designed incandescent lamp is placed in front of a silver plated reflector that is enclosed by a beveled plate glass cap. The leather handle is fastened by brass thumb screws that serve as terminals for the enclosed batteries. The switch for lighting the lamp is located in one of the screws completely sealed under a hard rubber cover.

The lantern contains four batteries in rubber cells that give a pressure of eight volts and have a capacity of four ampère hours. The batteries when fully charged will run the lamp from six to eight hours. The storage batteries may be readily charged by direct current or primary batteries. They are charged by hanging the lantern on hooks as shown in the initial letter. The projecting front prevents charging in the wrong direction. Fig. 1 shows the lantern in use by an oil inspector. The complete lantern, standard size, weighs five pounds.

The First Electric Railway with Underground Feeders.

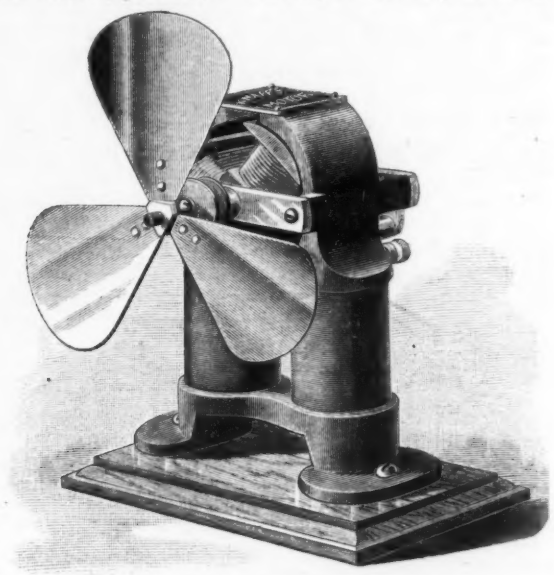
BY FRANCIS G. DANIELL.

In THE ELECTRICAL WORLD of Feb. 13, in an article by Mr. Carl Hering on "The Electrical Features of the City of Buffalo," the statement is made that the street railway is especially interesting, as it is the first large system to run its feeders underground. I think this honor belongs to Minneapolis, as in the summer of 1890, when the writer was electrical engineer of the Minneapolis Street Railway, all the feeders for a 3,000-h. p. plant were run in conduits, and bare wire was used. I think we were the pioneers, especially in the matter of bare copper.

The Knapp Electric Motor and Fan.

Several attempts have recently been made to combine in a small motor, which could be placed upon the market for a very reasonable price, a sufficient number of the desirable features of the larger motors to make it a substantial and at the same time an economical and well finished machine. A little machine which seems to meet these requirements is shown in the accompanying illustration. As will be seen from the cut, there is nothing radically new in its method of construction. It is a two-pole machine of the inverted horseshoe type, its two fields being so wound that it can be used on primary battery circuits. The armature is wound with three coils, their terminals being carried to the bars of the three-part commutator, which is carefully made and as well insulated as is usual with most of the much larger types. The bearings of the armature are carried in small brass bars attached to the pole-pieces, as shown in the cut. The brush holders are also attached to the frame of the machine. This little motor is ordinarily mounted upon a mahogany base, to which it is firmly secured, but should it be desired to attach it to a desk or table directly without a base it can be readily done, as the terminals of the field and armature coils are carried not upon the base but upon the frame of the machine. The armature shaft carries a three-bladed fan, which is about six inches in diameter, although an 8 or 10 inch fan may be used if desired, as the machine is capable of carrying one of that size. Two cells of battery are sufficient to drive this little ventilating fan at a very high rate of speed, while a single cell of dry battery is sufficient to give it as high a speed as is needed in very many cases. The machine is very small, and is probably the cheapest complete motor and fan that has ever been placed upon the market. It will be found very useful in such places as require only a moderate amount of ordinary ventilation.

Besides its use for ventilating purposes this motor can be used for driving toys, or for any small machines requiring only a light power. For this purpose a small pulley is supplied with each motor, which may be used in place of or in connection with the fan. This apparatus is manufactured and put upon the market by the Knapp Electric and Novelty Company, of 34 Warren street, New York City.



THE KNAPP FAN MOTOR.

Electricity Applied to Mining in West Virginia.

Since electricity is taking such a prominent part in coal mining every practical mining engineer is more or less interested in the large coal fields of this country and especially that feature of coal mining which has to do with the reduction in the cost of the operation of mines.

Mr. H. S. Sands, a consulting and constructing electrical mining engineer of Fairmont, W. Va., has sent us some facts regarding the West Virginia coal fields and the electrical machinery which has recently been put in operation in that section, which may be of interest to our readers.

The coal fields of that region begin near the northern line of Pennsylvania and extend southwestward through West Virginia, southeastern Ohio, eastern Kentucky and central Tennessee, ending in western Alabama, 900 miles from their northern extremity. The shape of this immense field, which lies in what is known as the Appalachian basin, has been compared to that of a rude canoe, the pointed ends being in Pennsylvania and Alabama, while the broadest portion lies in West Virginia and Ohio. Through West Virginia the thickness of the coal varies from six to sixteen feet. In the section around Fairmont is found a layer of good clear coal about eight feet thick. This coal is very accessible and easily operated, as many of the openings are in the sides of the hills so that the coal comes out on a level, and it is not necessary to sink a shaft to reach the coal.

One of the concerns operating in this rich coal field and which makes use of electricity to a considerable extent is the Monongah Coal and Coke Company. With a capital stock of $2,000,000 this company commenced operations at

Fairmont about two years ago, its first purchase being about 14,000 acres of coal land lying in a single body. The company decided to use electricity as much as possible, and now has in daily operation three 80-h. p. United States generators. The current from these machines is used to drive eight mining machines, two pumps and for doing general lighting about the mining works. The electromotive force of the dynamos is 220 volts.

The coal cutters used are of the Jeffrey type, which have already been illustrated in the columns of THE ELECTRICAL WORLD. The motor is placed directly on the top of the carriage, the power being transmitted from the armature shaft to the lower driving shafts by means of steel cut gears. As is well known a large sprocket chain is used to transmit the power to the cutter bar, this bar being fed forward by a rack and pinion to a depth of about six feet. A test of one of these machines was recently made, the readings of electromotive force and current being taken with Weston instruments. The following table gives the results of this test:

FIRST UNDERCUT MADE BY THIS SET OF BITS.

Rev.	Volts.	Ampères.	E. H. P.
1,200	250	20	7.038
1,200	245	25	8.21
1,200	245	30	9.83
1,200	230	40	12.33
1,200	230	43	13.26
1,200	230	45	13.87
1,200	230	50	15.42
1,200	230	54	16.65
1,200	230	55	16.96
1,200	250	50	16.74
1,200	245	51	16.74
	Backing out.		
1,200	250	30	10.05

Time, 7 m. In the test of this machine nine undercuts were made before its bits were changed.

SECOND UNDERCUT MADE BY THIS SET OF BITS.

Rev.	Volts.	Ampères.	E. H. P.
1,200	250	20	7.038
1,200	245	25	8.21
1,200	230	40	9.83
1,200	230	45	13.87
1,200	235	50	15.75
	Coming out		
1,200	250	26	8.71

THIRD UNDERCUT MADE BY THIS SET OF BITS.

Rev.	Volts.	Ampères.	E. H. P.
1,200	250	20	7.038
1,200	235	40	12.60
1,200	235	55	17.35
1,200	235	54	17.02
1,200	230	50	15.42
1,200	220	55	16.22
1,200	235	53	16.69
1,200	230	60	18.54+
1,200	230	56	17.27
	Coming out.		
1,200	250	27	9.04

FIFTH UNDERCUT MADE BY THIS SET OF BITS.

Rev.	Volts.	Ampères.	E. H. P.
1,200	240	25	8.043
1,200	230	40	12.33
1,200	230	47	14.49
1,200	230	50	15.42
1,200	230	55	16.96
1,200	230	59	18.50
1,200	230	57	17.58
1,200	240	60	19.30
1,200	240	56	17.62
1,200	240	65	.....
1,200	230	67	.....
1,200	230	70	.....
1,200	230	75	23.19
1,200	230	76	.....
1,200	230	80	24.66
1,200	230	85	26 18+

This great increase of power is due to bits being dull and also to a very hard place in the coal.

It will be seen at once that it is necessary in order to secure economical operation to keep the bits in good shape.

A portable mining pump is used, the pump and Perret motor used in its operation being mounted upon the same truck. This pump was placed in the pit a few months since and it is said has never caused any trouble or needed any repairs. It is operated all day, and owing to its great flexibility is now able to accomplish the work ordinarily done by three steam pumps. A test of this pump recently made shows that it delivers 300 gallons of water per minute against a lift of 30 feet, and is only using eight ampères at a pressure of 220 volts, the speed being 700 revolutions per minute.

Another Display of the Northern Lights.

A recurrence of the phenomena of the Northern Lights seen on Feb. 13 last took place Sunday evening, March 6, and those who looked at the northern sky early in the evening were treated to a display of aurora borealis well worth seeing, as a flood of brilliant light illumined the horizon in the form of an arch, its rays extending toward the zenith. The conditions for the display were not quite as favorable as in the former phenomena, owing to the position of the moon, which dimmed the effect to some extent. Scientists state that they believe we will continue to see a series of these displays for some time to come, which will be accompanied with electrical and magnetic disturbances.

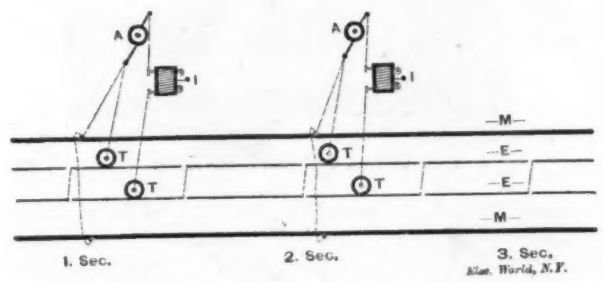
A New Electrical Block Signal System.

The accompanying illustration shows a diagram of an electrical block signal system which is the joint invention of Mr. George H. Thayer, superintendent of the Telegraph Department of the Chicago & Northwestern Railway, and his assistant, Mr. C. P. Carr.

The diagram is intended to show the main track of a railroad, with two trains running over the outside or main rails, *M M*, and *E E* are intended to represent an additional set of light rails placed between the main rails and divided into sections of any desired length connected as shown by the dotted lines. From each locomotive extend two insulated brushes, *T T*, making constant connection with these sectional rails. A small alternator, shown at *A A*, of low voltage, is placed in each locomotive cab and driven in any way that it is thought best. The power required is very small, and the speed may be both slow and variable without interfering with the working of the apparatus. It is claimed that the entire apparatus can be closed in a box about one foot square.

One pole of the alternator is connected through a properly made indicator *I I*, preferably a polarized bell, to one of the brushes. The other pole is connected constantly to both the frame of the engine itself and the second brush.

The frame of the engine is constantly connected, of course, with the outside rails through the engine wheels. Another conductor can be placed in the second brush circuit if desired, and so arranged that its effect will be to show "danger ahead" to one train and "danger behind" to the other when the two get upon the same circuit at the same time. The sections in the present diagram are



AN ELECTRICAL BLOCK SIGNAL SYSTEM.

marked 1, 2 and 3, each section operating the other half way. The trains shown are supposed to be both going in the same direction. It will be seen that should the rear train strike the forward section before the forward train leaves it the engineer will get an alarm which tells him that the section ahead is not clear, and he can act accordingly. The alarm, of course, keeps sounding until the section is clear.

It will be seen that the same arrangement can be applied equally well to either a single or double track road.

The model is on exhibition in the General Manager's room of the Chicago & Northwestern Railway.

The track and engine wheels when entirely submerged in water do not in any way affect the working of the apparatus. A similar apparatus to be placed on the rear of freight trains for use in case of parting of a train acts in the same way as if placed in the engine cab, and gives protection to the rear section of the train.

An attachment is also to be applied to indicate to the engineer the failure of the current and another improvement contemplated is that of a mechanical attachment on the locomotive in winter to keep the sectional rails free from ice and snow to such an extent as to permit a desirable electrical connection with the brushes.

Electrical Welding as Used in the Wire Industry.

BY ALBERT M. BULLARD.

(Abstract.)

Copper Wire.—Before the invention of an automatic device in electrical welding, the perfection of the joint depended largely on the skill of the operator. This element of uncertainty was removed by the introduction of the automatic welder, by means of which the electricity is cut off just as the weld is completed. The two resulting advantages are uniform welds and cheaper labor. For large sizes the hammering apparatus ought to be resorted to to restore the fibrous quality and strength of the metal in the vicinity of the weld. By this hammering operation the large welds are so strong that they will stand the severe test of being drawn thrcugh dies down to small sizes. The burrs or "upsets" are nearly removed when cold by shear dies, the welds are then heated electrically to a cherry-red color and brought down to sizes by the swages of the mechanical hammer. The whole process occupies a little more than a minute. In an experiment a number of unhammered welds were made in a length of copper wire of $\frac{1}{10}$ of an inch in diameter, and were subsequently drawn by successive draughts to the diameter of $\frac{3}{1000}$ of an inch without a break, which shows the perfection of the weld. In another test, for the electrical conductivity, short lengths of copper and iron wires were filled with welds and afterward tested for conductivity, showing in every case no loss in conductivity. The process is especially applicable for street railway feeders and the trolley wires, in which great lengths are demanded by the purchaser.

Iron and Steel Wire.—Iron wire is worked so easily and perfectly by electricity that there is very little to be said about it. The automatic principle is applied to iron wires also. After an hour's instruction a child of five years could operate an automatic wire welder. Steel wires of low grade, like Bessemer steel, differ but slightly from iron in welding. High carbon steel requires a greater amount of care, a little carbon is sure to burn out. It has been proved that the electrically heated metal is in no different state from the fire heated metal and that it does not crystallize, as was at first thought. It was even found that the metals are more uniform than when heated by a forge fire. High steel welds are made at not too white a heat rather quickly and under considerable pressure. The after treatment is similar to that given to copper except that the burrs are not sheared off but are reduced to size by a mechanical hammer. Little or no flux is used on high carbon wire and none at all on lower grades of iron, not on other metals, and the slight annealing necessary is effected by removing the red hot iron weld from the clamps and allowing it to cool slowly in the air. All but the high-grade carbons will stand drawing through die plates. The process is especially applicable to the manufacture of ropes, in which great lengths of cables are to be made. Electrical welding is in this case used to splice fresh lengths of wire on the spools as they are used up.

Silicon Bronze and Similar Compositions.—The process is especially applicable to the overhead trolley wires made of silicon bronze. The metal acts like copper, also like brass. By partially removing the burr and hammering by hand while cold the weld is brought to nearly the hardness and tensile strength of the original stock. Even more satisfactory welds were obtained when treated to hot hammering with a mechanical apparatus. The fracture near the weld has the fibrous appearance of a fracture of an unheated part. Brass, german silver, aluminium bronze and pure aluminium wires have been worked satisfactorily. With such suddenly melting metals the automatic welder is almost indispensable.

Steel Wire Cables.—There is a cable called "locked rope," which has been successfully welded by electricity. This rope is especially well adapted for street railway cable lines. Without electrical welding it never could have been used for this purpose. The strands are wound in such an ingenious way that no spaces exist between either layers or individual strands. The very innermost strands consist of a bunch of small round wires between which are the only spaces in the rope, and these are very small. Around these are wound, in a reverse direction, layers of wires each shaped like the keystone on an arch, fitting snugly between its neighbors. A sheath, or sometimes a double sheath, of interlocking "S" shape wires is tightly wrapped outside of all, in a direction opposite to the underlying layer. The result is a strong, compact, flexible rope. The problem was to weld all these wires together so as to maintain the tensile strength of the original cable without sacrificing flexibility. In making the weld it was necessary to prevent the wires from spreading and separating; also to supply the electricity to the rope from every side to insure each wire receiving its proper share of the heat. To meet the second difficulty a straight copper block was clamped firmly on to the cable. These blocks were placed in the welder so that the current entered each clamp and passed through them to the cable from all sides, a principle which was afterward applied very successfully to the welding of tubes. To meet the first difficulty iron collars were driven on the ends of the cable, beyond which the wires project very slightly to allow for a slight upsetting. A little rotating cutter of special design was brought to bear upon the collared ends, which has squared them off and then cut little concentric grooves between each layer. The object of this was to make each wire somewhat beveled, a necessary proceeding, because in welding the wires are not all welded into one promiscuous mass; each wire is placed opposite to its mate and becomes welded to it alone. Each little weld will form a small burr and by the beve ling above mentioned the size of these burrs is reduced to almost nothing. A finished rope weld is but a trifle greater in diameter than the rest of the cable. The weld is made in five seconds. A solid iron bar of such diameter would take nearly half a minute to weld. A one-inch cable of this kind is composed of about 100 wires, each of an average diameter of .125 inch. A sample weld pulled apart showed it to consist of individually welded wires except for the innermost bunch, which was composed of round wires irregularly twisted together; this was fused into a solid group. The results of tests showed that the tensile strength of the welds was nearly 90 per cent. of that of the unwelded rope. In the testing machine the breaks rarely occurred directly at the wires, but more frequently an inch away. In one test a cable was bent back and forward through an arc of 180 degrees 130 times without breaking; then it was hammered flat on an anvil and bent again several times. This certainly indicates a good rope and a good weld. The paper concludes by saying that the electric welding of wires and locked ropes is a practical success.

The Premier Electric Motor.

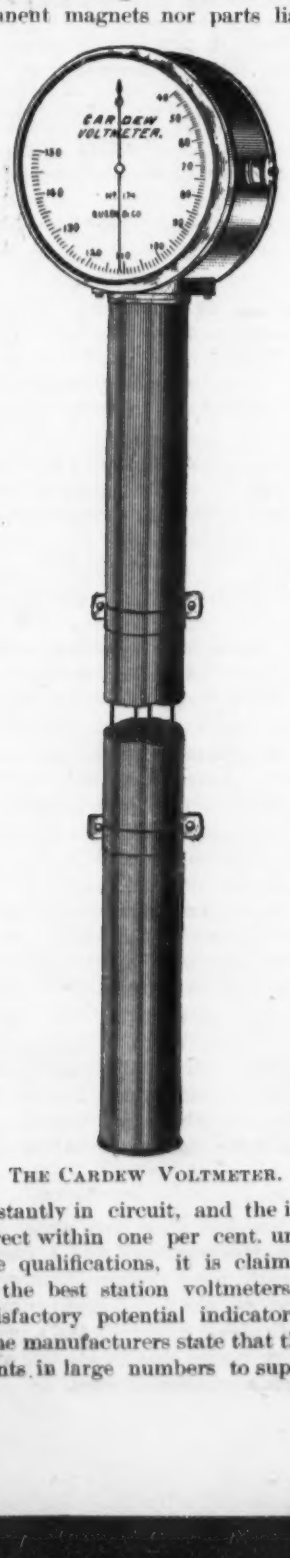
The illustration shows a battery motor for ventilating, running light machinery and other purposes where a motor of the kind can be used efficiently. It is especially adapted for ventilating the dining table, office desk, parlor or library, and is also designed to run toy launches, railroads, machine shops, music boxes, turn tables, etc., with one cell of battery (two volts). It is made from the best soft iron, enameled, finished and mounted on a hard wood base with

THE PREMIER MOTOR.

binding posts, and has brass driving pulley and oil cups in the bearings. With the opening of spring and the advance of warm weather motors of the kind will meet with considerable demand, as they can be easily operated, require no attention and are comparatively inexpensive. No new features are noted in the construction of this motor; yet at thesame time it is neatly built and made in all its parts of material adapted to all the wear which motors of this kind have to bear The Premier Electric Company, of 11 Whipple street, Brooklyn, N. Y., are the manufacturers.

The Cardew Voltmeter.

Since acquiring the American patents which control the Cardew voltmeter, Queen & Co. have made extensive preparations to manufacture this instrument. Special tools have been procured so that the mechanical parts may be constructed in the best manner possible, and in the new Queen laboratory every facility is offered for exact calibration. The Cardew has an enviable name as a standard voltmeter, for it possesses many desirable qualities, which have brought it into extensive use. It is dead beat, direct reading for both alternating and continuous currents, contains no permanent magnets nor parts liable to change.



THE CARDEW VOLTMETER.

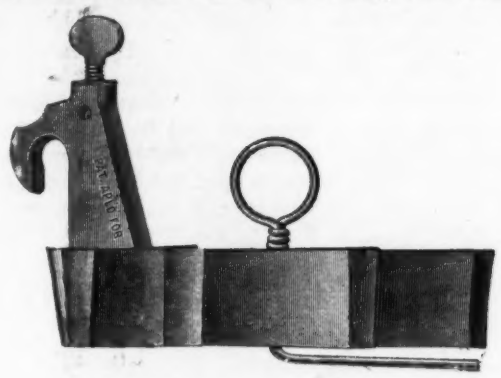
can be left constantly in circuit, and the indications, it is stated, are correct within one per cent. under all circumstances. These qualifications, it is claimed, render the Cardew one of the best station voltmeters on the market, and a most satisfactory potential indicator for marine installations. The manufacturers state that they are making these instruments in large numbers to supply the increasing demand.

The Delany Crowfoot Zinc.

One by one the standard articles used in connection with the electrical business are approaching perfection, and each new improvement seems to bring out the question, "Why was it not thought of before?" A glance at the illustration will show a simple improvement which every careful battery man or operator who has angled in a gravity cell with a piece of bent wire, smutching his fingers and twisting his neck for a minute or more trying to dislodge an inaccessible pendant, will welcome, and which will enable him to clean off a thousand zincs in a few minutes without splashing the shelves or soiling of clothes. With this improvement it will not be necessary to disturb zincs from the time they are placed in the battery until entirely used up.

The cut shows a wire sweep through the central toe of the zinc. The wire is bent on a horizontal plane with the zinc, so that by touching the eye end projecting above the solution the sweep is free to move in either direction so as to thoroughly sweep or brush the entire bottom of the zinc from centre to circumference, thereby sending all the spongy coating to the bottom of the jar. Heretofore this operation has been attended with so much difficulty that it was either imperfectly done or neglected altogether. Beside the great saving effected in zinc and copper, the resistance and effciency of all the cells of a battery will be uniform, as the laziest or most careless attendant will not fail to give the sweep an occasional twist.

The zinc itself is just like the ordinary Crawford zinc in common use, with the addition of the simple and effective



THE DELANY CROWFOOT ZINC.

means described above for the removal of the stalactite formations of spongy copper which form on the under side and hang down into the copper solution, thus setting up local action and causing great waste of zinc and bluestone.

Is is stated that the nature of the device is such as to add little or nothing to the cost of the zinc. The E. S. Greeley & Company have become the sole licensees for the manufacture and sale of this new zinc, which is the invention of Mr. P B. Delany.

A Ceiling Pendant Cut-Out.

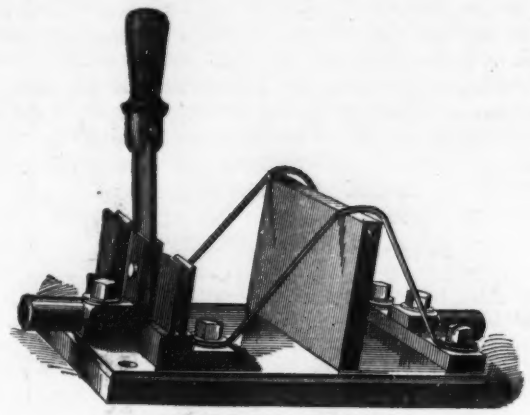
Another new form of ceiling cut-out has recently been added to the long list of special and improved devices now upon the market. The block illustrated herewith is a de-

CEILING PENDANT CUT-OUT.

velopment of a design by Mr. J. Van Vleck, electrician for the Edison Electric Illuminating Company, of New York, for whose special requirements it was originally made. The design is to embody in one block of small dimensions all the features that such an appliance should possess. The cut-out is adapted to both exposed and surface work; in the latter case the wires are brought directly through the base to the binding posts and do not appear on the outside of the cut-out. It has a square base and consequently is especially adapted to molding work. The interlocking contacts are substantially made and of such a character as to permit of no loose connections or the liability of the same working loose. Double pole safety catches are concealed in the cover, permitting easy renewal without disturbing the base of the block, and the room for making connections is not cramped. Possessing no external binding posts or metal parts, the block has found favor and received the indorsement, it is stated, of the Fire Underwriters. It is known as the V. V. ceiling cut-out and is manufactured by the Interior Conduit and Insulation Company.

A New Double Fuse Block.

The accompanying illustration represents a new double fuse block just brought out by Wm. H. Weston & Co., appliance and switch manufacturers, of Philadelphia. In this fuse block the plug arrangement, so inconvenient to manipulate, is discarded and its place taken by a simple knife switch, which is very easily thrown in from one side to the other as occasion requires; that is, when the fuse burns out. It is stated that this arrangement of fuse block has many points of merit to recommend itself to

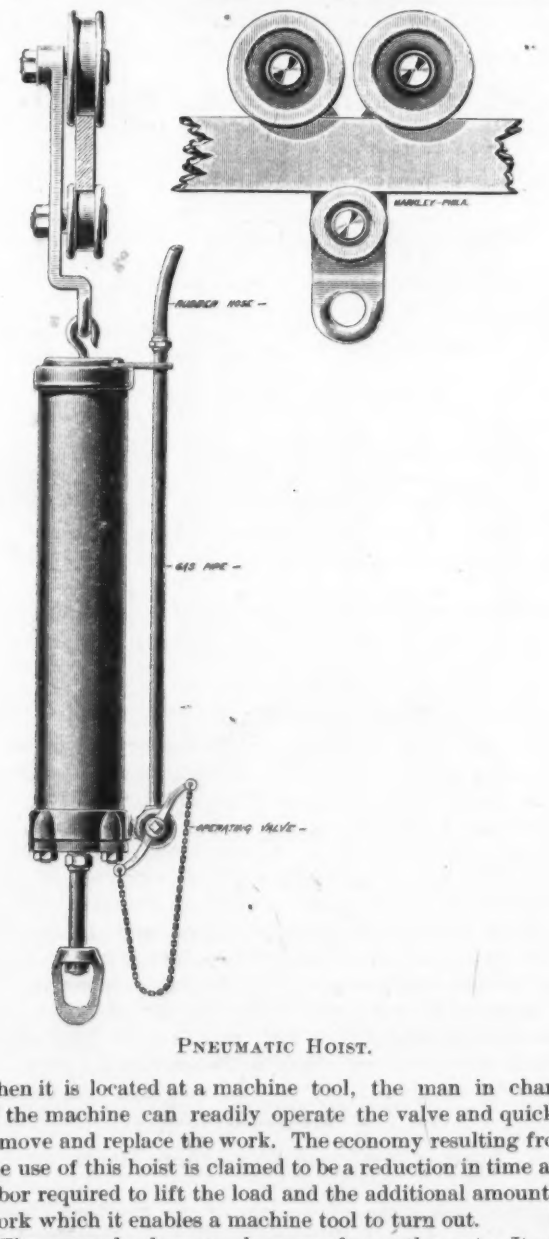


NEW DOUBLE FUSE BLOCK.

users of the article and that it will be found much better adapted and much easier to work than the old style.

A Pneumatic Hoist.

The use of devices for lifting light or heavy loads has become so large that many new appliances have been brought out for the purpose, which are being extensively used. Especially has the demand become very great for ready appliances for quickly and easily handling pieces of rock up to one or two tons weight. The ideal hoist is one requiring no manual labor to operate it, and one that will lift the load rapidly. We show in the accompanying illustration a pneumatic hoist which combines the two features referred to above. With this appliance the lifting requires but the manipulation of an easily operated valve, while the speed may be as high as desired. When it is used no manual labor is required, the power being obtained from compressed air, and no delay is experienced from waiting for shop laborers or slowly moving mechanism. One man can operate the necessary mechanism, and



PNEUMATIC HOIST.

when it is located at a machine tool, the man in charge of the machine can readily operate the valve and quickly remove and replace the work. The economy resulting from the use of this hoist is claimed to be a reduction in time and labor required to lift the load and the additional amount of work which it enables a machine tool to turn out.

The general plan can be seen from the cut. It consists of a small cylinder, to the upper head of which is fastened an ordinary pipe cap, to which there is attached a hook by which the hoists can be readily hung to the overhead trolley, and, if desired, can be transferred to different parts of the shop. The lower head is made of two castings,

one of which is screwed to the end of the cylinder and has a lug to receive a screw end of the valve which supplies the air for lifting. To this lower ring is attached a head which contains the stuffing-box for packing around the piston-rod. By this construction the lower head can be readily removed for an examination. The piston consists of a cast iron head, follower plate and a leather cup ring. The piston acts but one way, the weight of the load, or even the piston-rod and head, being sufficient to allow it to drop when the pressure from the lower end is relieved. The parts of the hoist are made strong and substantial. The power is supplied by an air compressor, one of which, 6 inches to 8 inches in diameter, with a storage tank of about 3 feet in diameter and 5 feet long, will supply sufficient compressed air for twelve to eighteen hoists having average use. For special purposes, such as where the hoist is used constantly, a less number can be supplied by a compressor of the above size. Hose is attached to the upper

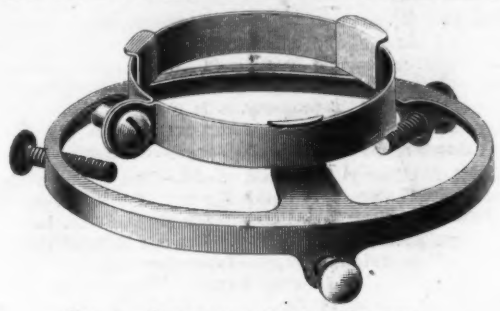


FIG. 1.—GERMANIA SHADE HOLDER.

end of the wrought iron pipe, the length of the hose depending upon the floor area which it is desired the hoist should cover. While special reference has been made to the application of the hoists at machine tools, they can readily be adapted to many places other than these. They are said to be as handy and as economical for loading and unloading material, their extent of application being almost indefinite. They are manufactured by Pedrick & Ayer, 1,001 and 1,003 Hamilton street, Philadelphia, Pa.

Germania Universal Shade Holder.

A shade holder so made that can be used on varying sizes of lamp sockets has long been in demand, and many efforts

FIG. 2.—GERMANIA SHADE HOLDER.

have been made to meet the demand, by bringing out a holder that would meet all the requirements.

The principal sockets on the market are the Edison, Thomson-Houston and Westinghouse, and of these the socket shell diameters are of two sizes. The Thomson-Houston and the Westinghouse are of the same size and the Edison is larger, so that two different sizes of clamping devices or rings are necessary to adapt a shade holder to them.

The Germania Electric Company, of Boston, claim to have solved the problem with their Germania Universal shade holder. Fig. 1 shows this shade holder as used on the Thomson-Houston and Westinghouse sockets, which

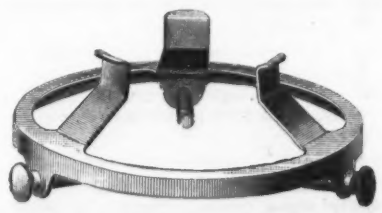


FIG. 3.—GERMANIA SHADE HOLDER.

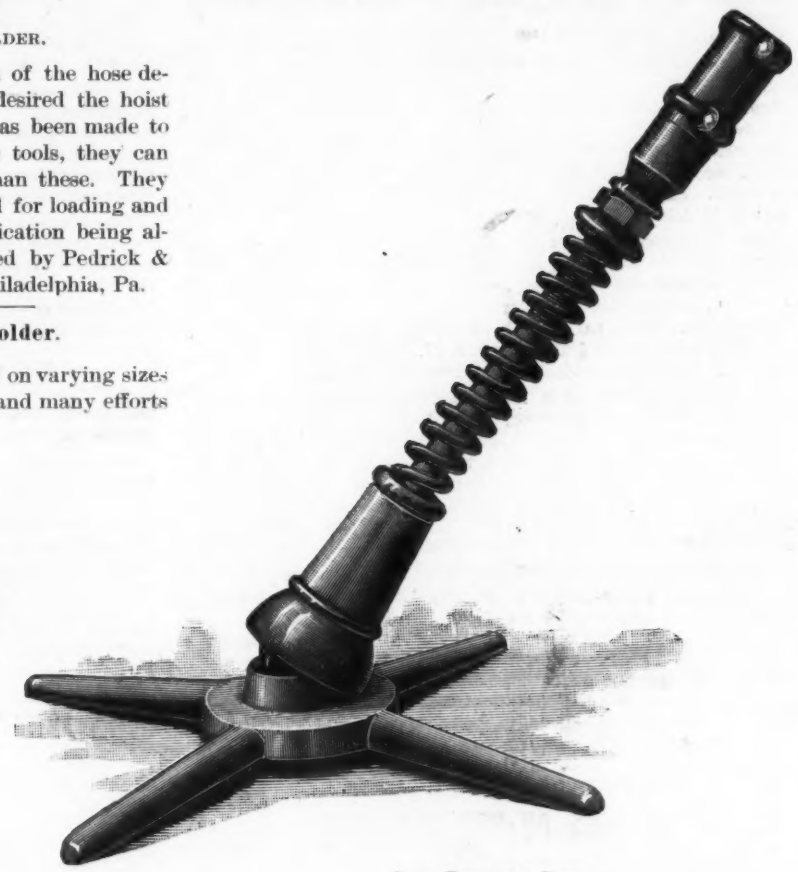
will be seen is the ordinary method pursued of attaching any shade holder. Figs. 2 and 3 show the method of applying it to the Edison socket, which is done by unscrewing the rubber ring, inserting the prongs into the brass shell, as shown by the figures, and replacing the rubber ring. The claims for this shade holder are that it fits all standard sizes of sockets, is simple, strong and artistic, and has no weak points and no joints to work loose.

A New Storage Battery Car.

The Woodland Avenue and West Side Street Railroad Company, of Cleveland, Ohio, has been testing a new storage battery car, with the view of equipping its lines with the same should the test prove successful. The car which is being tested is one manufactured by the Ford & Washburn Electric Company, of Cleveland, and is called the "Ideal." It measures 21 feet inside over all, and is equipped with 180 cells, which are placed under the seats, serving to operate a 40-h. p. Ford & Washburn motor. One charge, it is stated, is sufficient for 50 miles on an ordinary track. A recent issue of the Cleveland *World*, referring to the new car, had the following: "Supt. Mulhern, of the Woodland Avenue and West Side Street Railroad Company, is very much pleased with the system, and says that it is very probable that it will be adopted by the company. The new car will be run on the Woodland line among the other cars for a few weeks as a further test. It will make all the regular stops to pick up and let off passengers, and if this proves satisfactory a large order for cars will at once be placed with the company."

Sill Trolley Base.

The Sill trolley base shown in the illustration has but one spring, which gives a steady pressure on the wire. It is so made that the pole may come to the roof of the car without injury to the spring. The pole can be swung from the front to the rear of the car at an almost horizontal position without injury to the base, and it can also be left in a horizontal position for any reasonable length of time without injury to the spring. The action of the base gives to the trolley a free and easy movement on the wire at any angle, which can be regulated to the distance desired. The spring is made of the best oil-



SILL TROLLEY BASE.

tempered steel, and is compressed in its action instead of elongated. The pole is held in a socket in such a way that it becomes disengaged if the trolley should catch in the wire, so that breaking of the latter is prevented. The castings are made of the best gray iron, and are neat in design, without angles to cause easy breaking. The base weighs 55 lbs. complete, and has been commended, it is stated, by all those using it. Alfred G. Hathaway, of Cleveland, is the sole agent for it.

A Useful Accessory for Electrical Supply Houses.

A long felt want of the electrical supply business has been a proper means of arranging the many thousands of odds and ends so that the hand could be placed on any article designated at a moment's notice. Quick and prompt service is as highly appreciated in the electrical business as in any other, and the business man who has his stock arranged in an attractive manner and every article so placed that each can be easily found is the one who will do a successful business. Jesse Jones & Co., box manufacturers, 615 Commerce street, Philadelphia, have taken the proper view of the situation, and are manufacturing shelf boxes peculiarly adapted to the requirements of the electrical trade. These boxes are strongly made of well seasoned hard poplar wood, with corners locked and bottoms grooved in. There are no nails or screws to work out and cut the shelving, and the bottoms are made to stand any heavy wear and tear. For screws or small goods they can be divided into two or more parts with movable partitions grooved and set in the sides. The partitions can be removed at will, leaving the box full size. Where the boxes are used singly on the shelf, the bottom is "set up" a little, leaving the sides to act as runners; where two or more are used on the shelf the bottom is set flush with the sides. They are designed to fit snug all around and present a very pleasing appearance on the shelf, and are made to measure and in any shapes required. Electrical companies will do well to communicate with the manufacturers, Jesse Jones & Co., 615 Commerce street, Philadelphia, Pa.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, March 5, 1892.

The condition of the financial stock market has not materially changed during this week. The prevailing tendency has been downward, and all the prices have been depressed and weak, excepting during the past few days, when renewed activity and strength seemed to return, and the market became more buoyant. The principal business of the market has been on specialties, and, as is always the case with a narrow market, the other stocks have become weak in proportion to their inactivity. The narrow market of the week has not included the electric stocks, and there is no point of interest to chronicle regarding these securities. After the great consolidation is finally effected, and the new company's stock is listed, we may look for further activity and higher prices; but until then, and on such an uninteresting market as this, we can expect little else than we now have. General speculation has been materially restricted by gold exports, which have begun in earnest. However, any excitement which may be aroused on this account can be only an invention of the bears, and not a legitimate cause for any apprehension that the market will be demoralized for lack of staple currency sufficient to supply the demands of the country. In sending gold to Europe, we receive in return our best American securities, and at present low prices the exchange is not to our disadvantage. The money market has begun to show signs of hardening, and higher rates have been charged than at any time since the beginning of the year, but still they remain very low and have not yet reached the average. The National Bank returns show that money is moving much easier than it has been recently. There is a healthy increase in deposits and loans, an evidence that funds are no longer remaining stagnant, but finding the natural channels for activity and investment. The rates on commercial paper average about one-half per cent. higher than last week. Call loans are made at from three to four per cent., and time loans on the best paper from four to five and one-half per cent.

Thomson-Houston stock has been up again near the top figures, and the quotations are about $2 higher than it closed last week. The rise is due particularly to the statement that the company had secured the contract for equipping the Brooklyn City Railway with electrical apparatus. This is the largest contract ever secured, and far exceeds in the aggregate the West End company's contract in Boston. It will crowd the railway department of the company to its fullest capacity for many months, and has acted as a good point in favor of higher prices on the stock.

Fort Wayne stock was sold at the lowest figure that it has reached for many months. There is a plan on foot to decrease the annual dividend from $1.50 to $1.00 per share, this to be guaranteed by the Thomson-Houston company. This has acted as an argument to depress the stock, although the matter has not been settled and as a matter of fact it should not seriously affect the price.

Western Union has been bought by some, the expectation being that an increase by the directors of the quarterly dividend to 1½ per cent. will be recommended at the meeting of the executive committee, Tuesday, March 8.

The recent incorporation of the Siemens-Halske Electric Company at Chicago is a matter of great importance. It means the establishing in this country of the most powerful electric manufacturing company in all Europe. Settling thus in the central point of our country, it plans to make its presence felt in every quarter. It is interesting to compare with this importation of a great German company's interests to this country the new departure which the Thomson-Houston International Electric Company has recently made in combining with German capitalists and manufacturers and establishing a new company in Berlin, which will further the Thomson-Houston interests, and manufacture there Thomson-Houston apparatus.

Coupons of the first mortgage bonds of the Mount Morris, N. Y., Electric Light Company are being paid by the Central Trust Company.

To Issue Bonds.—The directors of the Haywards (Cal.) and Oakland Electric Street Railway have decided to issue $250,000 in bonds. Bonds will be issued by the town of Martin's Ferry, O., to establish an electric light plant.

Sale of Bonds.—The Olympia (Wash.) Light and Power Company has sold its bonds in Boston, receiving $150,000 for the same. The Winthrop National Bank and F. S. Mead & Co., bankers, Boston, are offering $275,000 worth of Lynn & Boston R. R. Co. five per cent. 20 year bonds, and are recommending them as a most desirable investment. This company is preparing by the issue of bonds to equip its road with electricity, and it will be run with the new motive power at an early date.

Dividends.—A quarterly dividend of 2 per cent. will be paid on Northwest Thomson-Houston Electric preferred stock March 15, 1892, to stockholders of record March 5. Books will be closed March 5 to March 15 inclusive.

Increase in Capital Stock.—The capital stock of H. Ward Leonard & Co., of New York, has been doubled, the increase having been taken by a gentleman prominent in the leading railway, banking and gas interests of New York City. The Standard Electric Time Company, of New Haven, Conn., has increased its capital stock from $15,000 to $25,000. The Chicago Water, Gas and Electric Light Company has certified to an increase in capital stock from $190,000 to $300,000. The Edison Electric Illuminating Company, of Boston, has asked for authority to increase its capital stock from $2,000,000 to $5,000,000. The Electric Light Company, of Raton, New Mexico, has certified to an increase in capital stock from $10,000 to $20,000.

Decrease in Capital Stock.—The Chillicothe, Ill., Water, Electric Light and Power Company will vote on March 29, on the decrease in its capital stock from $500,000 to $35,000.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, March 5, 1892, in New York and Boston:

NEW YORK QUOTATIONS.

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
Western Union Telegraph Co.	100	86,200,000	88⅛	88⅝
Commercial Cable Co.	100	7,716,000	149	150
Edison General Electric	100	15,000,000	98½	99
Consolidated Electric Light	100	2,500,000	20	30
Edison Illuminating Co., of New York	100	4,500,000	81½	82½
" " " Brooklyn	100	750,000	74	78½
" " " Chicago	100	750,000	138	142
U. S. Illuminating Co.	100	1,250,000	30	35
Edison Elec. Light Co. (of Europe) stock	100	2,000,000	2½	5
" " " bonds	sh	30,000	65	75½
" Ore Milling Co	100	2,000,000	17½	22½
" Toy Phonograph Mfg. Co	10	1,000,000	....	⅛
U. S. Electric Light Co.	100	1,500,000	15	20
Brush Illuminating Co., of New York	50	1,000,000	40	50
Mt. Morris Electric Light Co.		500,000	20	40
East River Electric Light Co.	100	1,000,000	...	60
North American Phonograph Co.	...	6,600,000	4½	6
New York Phonograph Co.	...	2,000,000	3	4
Automatic Exhibition Co.	...	2,000,000	2	2½
New England Phonograph Co.	...	2,000,000	1¾	2¾

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec....	25	6,000,000	60	58	59	59¼
Thomson-Houston Elec. preferred.....	25	4,000,000	29	28¼	28¾	29
Thomson-Houston Elec.—Series C	sh	40,000	....	....	8¼	9
Thomson-Houston Elec.—Series D.....	sh	120,000	7¾	7⅛	7⅛	7¾
Thomson-Houston Int'n'al Elec.....	100	600,000	....	....	200	210
Thomson-Houston Int'n'al Elec—Pfd.....	100	400,000	....	....	103	105
Thomson Elec. Weld.. ...	100	1,000,000	60	....	60	....
Thomson European Elec. Weld.....	100	1,500,000	12	....	12	13
Westinghouse Elec.—Pfd.	50	10,000,000	25	24	24	25
Westinghouse Elec. —Trust receipts	..	.....	15⅝	15	14⅝	15
Fort Wayne Elec.....	25	4,000,000	13¾	12¼	12⅛	12⅝
Fort Wayne Elec.—Ser. A.	sh	80,000	7¼	....	7⅛	7¼
Detroit Elec	10	1,000,000	8	....	7⅞	8
West E n St. Ry. Co.—Com	50	7,150,000	74	73½	73¼	74
West End St.Ry.Co.—Pfd	50	6,400,000	87½	85¼	86⅞	87¼
American Bell Tel.....	100	15,000,000	209¾	209	209	209½
Erie Tel. & Tel. Co.....	..	4,800,000	46¾	45½	45½	46½
Mexican Tel. Co.....	10	1,280,000	105	....	1.	1.10
New Eng. Tel. & Tel. Co.	..	10,304,600	53	52	51	52
Tropical Tel. Co.....	10	400,000	....	....	30	50

NEW INCORPORATIONS.

The Roseburg Electric Light and Power Company, of Salem, Ore., has been started with a capital stock of $20,000. J. E. Hurd, L. L. Hurd and Otey Boon are the incorporators.

The Columbia Electric Transmission Company, of Springfield, Ill., capital stock $500,000, has been formed. The incorporators are Gustave Monrath, Charles G. Armstrong and Clarence Griggs.

The Tremont Light and Water Company, of Portland, Ore., capital stock $10,000, has been started to supply water, gas and electric lights. W. C. Avery, A. C. Churchill and E. E. Howes, all of Portland, are those interested.

The East Side Power Company, of Portland, Ore., capital stock $50,000, has been formed to manufacture, purchase, sell and deal in electricity. David Goodsell, A. A. Franklin and G. A. Steel, all of Portland, are the incorporators.

The K. A. P. Electrical Novelty Company, of La Crosse, Wis., capital stock $15,000, has been organized to manufacture and sell electrical novelties. D. Frank Powell, Wm. D. Kurz and Hans Amundson are the incorporators.

The Pioneer Electrical Company, of Aberdeen, Minn., has been formed with J. L. W. Zietlow as secretary and manager. The company has secured the exclusive agency of North and South Dakota for the Ball system of electric lighting.

The Hollister Light and Power Company, of San Benito County, Cal., capital stock $25,000, has been formed. The directors are Thomas Donovan, E. A. Crepin, F. E. Kenney, William Palmtage, A. Tonn, Thomas McMahan and G. C. Nash.

The Longmount Electric Light and Power Company, of Highland, Colo., capital stock $50,000, has been formed to supply that town with electric light and power. Robert H. Porter, Irving R. Darrow and E. A. Arbuckle are the organizers.

The Chicago & Edison Park Electric and Street Railway Company, of Chicago, Ill., capital stock $500,000, has been formed to build, maintain and operate street railways. William Zuetell, N. H. Hanchette and E. Noel are the organizers.

The Little Falls Electric Light and Power Company, of Little Falls, N. Y., capital stock $30,000, has been formed for the manufacture of electricity for light, heat and power in Little Falls. James H. Ives, W. F. Lansing and George O. Oppel are the incorporators.

The Ferguson, Ruthenberg Company, of Louisville, Ky., capital stock $25,000, has been organized to buy and sell electrical and other machinery. The promoters are Richard Ferguson, T. Ferguson, both of Louisville; and Marcus Ruthenberg, of New Albany, Ind.

The Creede Electric Light and Power Company, of South Creede, Colo., capital stock $50,000, has been incorporated to furnish electric light and power to South Creede, Jimtown, and vicinity. John H. Poole, Wm. G. Barker and John W. Flintham are the incorporators.

The South Bethlehem & Saucon Electric Street Railway, of South Bethlehem, Pa., with a capital stock of $100,000, has been formed to operate an electric street railway in South Bethlehem and Saulsbury, Pa. Thos. Haney, J. B. Meixell and John Evran are the organizers.

The Buffalo and Niagara Falls Electric Light and Power Company, of Buffalo, N. Y., capital stock $100,000, has been formed to produce electricity for heat, light and power. The incorporators are George Urban, Jr., Cheektowaga; Jas. Roberts, Buffalo, and Daniel O'Day, New York.

The Johnson Standardizing Company, of New York, capital stock $10,000, has been incorporated to manufacture, sell, lease and use machinery and articles of every kind appertaining to electricity, etc. Edward H. Johnson, E. W. Little and T. E. Greenfield, all of New York, are the organizers.

The Menomonee Electric Light and Power Company, of Menomonee, Wis., with a capital stock of $30,000, has been formed to produce and transmit electricity for lighting, heating, etc. E. Marks, A. H. Johnson, A. Quilling, F. B. Wilson, L. S. Tainter, F. E. Fletcher and J. D. Hills are the promoters.

The Union Electric Company, of Seattle, Wash., with a capital stock of $1,000,000, has been formed to operate electric light and power plants, machinery, etc., acquire franchises, buildings, etc. J. M. Frink, C. P. Stone, Jas. McWilliams, M. L. Wright, and T. H. Tyndale, of Seattle, are those interested.

The Water and Light Company, of Nebraska City, Neb., capital stock $300,000, has been organized for the construction, maintenance and operation of a system of water-works and lighting and to furnish electric power in Nebraska City, Neb. E. E. Anderson, T. L. Watson and W. S. Downs are the organizers.

The Cayadutta Electric Railroad Company, of Gloversville, N. Y., with a capital stock of $120,000, has been incorporated, to operate a street surface railroad from Gloversville to Fonda. Thomas C. Frenyear, of Buffalo; A. N. Broadhead, of Jamestown, and Charles M. Gibson, of Schenectady, are the incorporators.

The Buffalo, Bellevue & Lancaster Railway Company, of Lancaster, N. Y., capital stock $90,000, has been formed to operate a street surface railroad by electricity or otherwise from Buffalo to the village of Lancaster, about seven miles. Henry W. Box and John L. Williams, both of Buffalo, N. Y., are the incorporators.

The Wright Universal Electric Company (incorporated in West Virginia), of New York City, with a capital stock of $5,000,000, has been formed to manufacture and deal in machinery for producing electric light, heat and power, etc. Wm. Wright, Julius Hershfield and Andrew Morison, of New York, are the organizers.

The Sanger Electric Light Company, of Sanger, Fresno Co., Cal., capital stock $75,000, has been organized to deal in and operate electric inventions, light and power plants, street railroads, etc. H. W. Chase, Edw. Reynier, R. H. Elder, C. B. Presley and George W. Bates, all of Sanger, Cal., are the promoters.

The Buffalo and Lancaster Electric Railway Company, of Cheektowaga, N. Y., with a capital stock of $200,000, has been formed to operate a street railway in Erie county. George M. Browne, 84 Anderson street; Charles Rossler, 572 Niagara street, and Richard R. Ditzel, 21 Vary street, all of Buffalo, N. Y., are the organizers.

The Mineral Ridge & Niles Electric Street Railway Company, of Mineral Ridge, O., with a capital stock of $50,000, has been started to construct and operate an electric street railway between Mineral Ridge and Niles, O. The incorporators are Edward Blunt, W. W. Rosenthal, C. F. Whitney, E. J. Ohl, W. T. Williams, George Reeves and J. W. Benedict.

The Columbia Electric Transmission Company, of Chicago, Ill., capital stock, $500,000, has been incorporated. The purpose of this company is to exhibit at the World's Fair, to demonstrate long distance transmission of electric currents in large quantities, and to construct electric plants to supply light and power, etc. Gustave Monroth, Chas. G. Armstrong and Clarence Griggs are the incorporators.

The Sioux City and Leeds Electric Street Railway Company, of Sioux City, Ia., capital stock $200,000, has been formed to construct, maintain and operate street or other railways in or adjacent to Sioux City, operated by horse, electric or steam power. A. M. Coffman, W. E. Higman, W. M. Stevens, C. C. Peirce, Maris Peirce, E. W. Skerry, of Sioux City, and A. W. Gates Fairbanks, of Boston, Mass., are the promoters.

The Nolton & Adams Hardware Company, of Port Townsend, Wash., capital stock $20,000, has been formed to deal in hardware, stone, tinware, wooden-ware, ship chandlery, building materials, sporting goods, wagons, buggies, farm machinery, gas and electric fixtures, and carry on a general plumbing and repair business. Theron J. Nolton, E. C. Adams, Port Townsend, Wash., and A. H. Adams, Helena, Montana, are the organizers.

The Tacoma Mine and Manufacturing Company, of Tacoma, Wash., with a capital stock of $200,000, has been formed to grow, purchase and sell all kinds of mines, etc., etc., and to operate railways, telegraph and telephone lines, water works, and electric light plants. Erasmus Bennett, of Topeka, Kan.; Jackson Hunt, Jas. B. Rowley, Isaac H. Durborow, J. M. Hayes, W. P. Bonney, W. H. Hollis and C. L. Hoska, all of Tacoma, are the organizers.

The Puget Sound & Alaska Commercial Company, of Seattle, Wash., capital stock, $25,000, has been organized for the fishing business in Washington and Alaska, also in same place to operate canneries, fishing stations, vessels and boats of all kinds; construct and operate sawmills, wharves, electric light and power plants and do a general merchandise business. Lester Turner, Louron Ingels, E. L. Skog, John Hill, Seattle, Wash., and John D. Boyd, Duluth, Minn., are the organizers.

The Idaho Aluminium Mining and Manufacturing Company, Spokane, Wash., capital stock $100,000, has been formed to buy and sell mines, mining claims, water rights and other real and personal property in Washington and Idaho; engage in mining and manufacturing of aluminium, fire, fancy and pressed brick, tiling, pottery, etc., lumber and wooden ware; buy, sell and smelt ores; construct and operate reduction works. Frank Johnson, J. C. Poets, N. G. Melmgren, Spokane, Wash.; Henry Melder, Bethdrum, Idaho, and D. N. McChesney, Albino, Idaho, are the promoters.

AFFAIRS OF THE COMPANIES.

The E. T. Ford Electric Company has established a branch in Fort Worth, Texas.

A receiver has been appointed to take charge of the Knoxville (Tenn.) Street Railway.

The Electric Light and Gas Companies, of Fort Dodge, Iowa, have been consolidated under the title of the Fort Dodge Gas, Electric Light and Power Company.

The Hartford Electric Light Company has elected A. C. Dunham, president; E. B. Bennett, vice-president; H. M. Clark, secretary and treasurer, and Thomas Evans, auditor.

Receiver Appointed.—Thomas Steele has been appointed receiver of the Indianapolis Street Railway Company, and the strike which has been pending so long, it is thought, will be practically settled.

The Rock Island County Brush Electric Light Company's plant at Rock Island, Ill., has been sold by the receiver. It was bid in by the Brush Electric Company, of Cleveland, for $10,500.

Mr. George Westinghouse, Jr., has given a public denial of the statements that the Westinghouse company has asked, either directly or indirectly, to be taken into the Thomson-Houston-Edison electrical combination.

Sea Isle City, N. J.—The sheriff has seized the property of the Edison Electric Illuminating Company on an execution issued at the instance of Morris Boney, president of the Seashore railroad. It will be sold on March 25, and will include the plant that lights the city.

Bucksport, Me.—Hon. O. P. Cunningham has been appointed receiver of the Bucksport electric light property. A final hearing will be had in April, and it is stated that the plant will be kept running and strenuous efforts made to place the company on a paying basis.

Middletown, Del.—The electric light company has made an assignment, and Lawyer Martin B. Burris has been appointed receiver. The business is now in his hands, and the plant will doubtless soon be sold. The lights will go on as usual until an adjustment is effected.

The report that the Detroit Electric Light and Power Company had decided to issue $300,000 of bonds guaranteed by the Fort Wayne Electrical Company has been declared untrue by Mr. Ralph Phelps, Jr., who states that the proposition to issue bonds to take up current obligations was discussed, but no action taken.

The Chillicothe Water, Electric Light and Power Company, of Chillicothe, Ill., will hold a special meeting, March 29, for the purpose of decreasing the capital stock of said company and for the election of a director of said company, in place of Samuel B. Hartz, deceased, and for such other proper business as may come before said meeting.

The Kewanee Electric Light and Motor Company, of Kewanee, Ill., at a recent meeting elected the following board of directors: C. E. Barney, W. G. Wood, J. K. Blish, W. F. Swadkins and G. A. Anthony. The directors elected the following officers: C. E. Barney, president; W. G. Wood, secretary and treasurer. Reports showed the business of the company in a thriving and satisfactory condition.

The Union Telegraph and Telephone Company, of Albany, N. Y., at a recent meeting elected the following directors: James P. Davis, C. I. Glidden, A. B. Uline, David B. Parker, C. E. Durkee, E. H. Peter and H. L. Storke. The following acted as inspectors: W. B. Butler, James J. Fitzsimmons and Henry E. Hawley. The election of officers was postponed on account of the absence of one of the directors.

Assignment of an Electric Plant.—The Citizens' Electric Light and Power Company, of Muscatine, Ia., in which Davenport capital is largely interested, recently assigned in favor of Mr. R. T. Miller, of Davenport. There is but $2,144.56 owing, and it is hoped that the company will soon be on its feet again. It is is said that the assignment was caused as much by the conflicting interests of the stockholders as by the creditors.

The street railway system of Macon, Ga., is to be sold March 31. The court's decree is that $25,000 must be paid in cash at the sale, the balance being paid as the court requires. The Thomson-Houston company holds all the railway company's securities and will buy in the property, it is stated. Over one hundred thousand dollars will be spent in improvements in the way of new cars, extending the lines and building a power station.

Street Railway Ordered Sold.—The Superior Court has ordered that the property of the Keokuk Electric Street Railway and Power Company, now in the hands of a receiver, be sold after thirty days' notice has been given. The sale to be without the right of redemption, and to convey the interests of all parties to the litigation which resulted in a receivership. The property consists of a power house, machinery, cars, tracks and franchise of company.

The Joint Consolidated Committee of the Thomson-Houston-Edison Company have issued a circular, stating that the agreement of consolidation has now become operative and is binding on all parties who have subscribed, and further stating that the stockholders who do not deposit their stock according to the terms of the agreement on or before the 28th day of March shall forfeit any right to come in under said agreement, except by the express permission of the committee and on such terms as it may impose.

The plant of the Capital Electric Company, of Nashville, Tenn., has been sold to the Thomson-Houston Electric Company for $75,000, pursuant to a decree rendered by the United States Circuit Court, Dec. 19, 1891, in the case of the Thomson-Houston Electric Company vs. the Capital Electric Company, in favor of the Thomson-Houston Electric Company for $80,583.88, and to satisfy other indebtedness of the Capital Electric Company. The sale was free from the equity of redemption. It is understood that the property will be transferred to the Cumberland Electric Light and Power Company, and will be very much enlarged by the building of a new plant on the river site.

Northwestern Thomson-Houston Electric Light Company.—The following item appeared recently in the Anaconda (Mont.) *Standard:* "An authenticated copy of the articles of incorporation of the Northwestern Thomson-Houston Electric Light Company has been filed for record, together with the appointment of H. A. Turner, of Helena, as agent of the company. The same company filed an annual statement, which gives the capital stock at $1,253,600 on Feb. 1, 1892. The amount actually paid in in money is $610,100. The amount paid in in other ways is $643,500, $110,000 of which is in franchises and territorial rights, and $536,500 in merchandise and accounts. The assets are $2,183,098.89, with liabilities of the same amount. Of the capital stock $750,000 is common, and $503,600 preferred.

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-177 Times Building, New York, March 7, 1892.

M. W. Hayden left on Wednesday last on his semi-annual trip for the Lew Telephone Company. He will stop at the principal cities West as far as Denver.

Mr. F. S. Blackall, New York City, agent for the Crocker-Wheeler Electric Company and the Carpenter Electric Heating Manufacturing Company, has removed his office to No. 126 Liberty street.

The Crocker-Wheeler Motor Company has just installed a 3-h. p. motor in the Holland House, Fifth avenue and Thirtieth street, to run a 48-inch J. H. Seymour fan for ventilating the shaft.

The Security Insulator Company, 136 Liberty street, has received a third order from the same party for insulators. The insulators which they manufacture have also been approved by the underwriters of Philadelphia.

Mr. Fred. C. Ross is now manager of the New York office of the Eddy Electric Company, vice Walter C. McIntpre, who has returned to Philadelphia to look after his interests in the Walter C. McIntyre Company, which have grown so largely that they require his constant attention.

American Institute of Electrical Engineers.—The sixty-fifth meeting will be held at the headquarters of the Institute, No. 12 West Thirty-first street, this city, Tuesday evening, March 15, at 8 o'clock. A paper will be read by Mr. Alexander Wurts, of Pittsburgh, on "Lightning Arresters."

Mr. M. C. Sullivan, formerly with the Edison General Electric Company, and later with the *Electrical Engineer,* is now representing the New Process Raw Hide Company, of Syracuse, with offices at room 534 Electrical Exchange Building. Mr. Sullivan's extensive acquaintance will no doubt soon make the raw hide specialties more popular than ever in the electrical field.

The Premier Electric Company, of 11 Whipple street, Brooklyn, N. Y., is in the field with a line of small motors, sizes one, two and three, and is manufacturing a number of novelties that no doubt will have a good sale. Mr. E. F. Kelly, formerly of the Porter-Lovett Company, Providence, and Mr. M. Rodrigues, a well-known electrician, are the managers of the company. They are now building a two-story brick factory which, when completed, will give them ample facilities to quickly fill all orders.

Mr. C. O. Baker, Jr., master of transportation of the National Electric Light Association, has sent us the following communication: On behalf of the National Electric Light Association I desire to tender thanks through the electrical press to the following named gentlemen, for the very efficient service rendered and the numerous courtesies extended to our delegates during the recent convention in Buffalo: Mr. M. C. Roach, general Eastern passenger agent, N. Y. C. & H. R. R. R., New York City; Mr. Edson J. Weeks

general agent passenger department, and Mr. H. H. Parry, city ticket agent, Buffalo, N. Y.; Mr. J. C. Yager, division superintendent Wagner Palace Car Company, New York.

The enterprise of the Albany Railway Company since the change from horses to electricity as a motive power is noteworthy. Not only has it extended its lines about the city and is intending to take in several more streets, but it has absorbed the Watervliet Turnpike and Electric Railway Company, which runs from the central part of Albany to Troy. This acquisition about doubles the mileage of the Albany railway. It is also being generally understood that this road has now absorbed the North and East Greenbush road, and intends to equip it with motors in the spring. Its line will also be further extended in Greenbush. The Albany railway has a plant that ranks with the most extensive and complete electric railway plants in the country.

A New Theatre Plant in Brooklyn.—Those of our readers who have had an opportunity of examining the plant in the Carnegie Music Hall in this city will be pleased to know that a very similar installation has been made in the Columbia Theatre in Brooklyn. This new plant takes its current, however, from the central station. The total number of lights is about 2,000, most of which are hidden or sunk somewhat below the surface of the walls. Some, however, are hung in clusters about the balconies. The large proscenium arch is completely surrounded with lights, so hidden from view as to produce a very good effect. The contractors for the lighting installation were H. Ward Leonard & Co., of this city, and the work was done under the direct supervision of Mr. William B. Martin, whose work at the Carnegie Music Hall has earned for him a well-merited reputation. Mr. Martin goes in a few days to Baltimore to superintend the installation in the Equitable Building in that city, the contract for which has been secured by the Western Electric Company, of Chicago.

The Hudson River Telephone Company at a recent meeting elected the following directors: Joseph P. Davis, C. J. French, James Biglow, James H. Manning, D. Cady Herrick, John E. Hudson, Andrew B. Uline, Henry L. Storke and David B. Parker. W. B. Butler, H. E. Hanley and J. J. Fitzsimmons acted as inspectors. At a meeting of the directors held subsequent to their election the following officers were elected: President, James P. Davis; vice-president and general manager, A. B. Uline; secretary and treasurer, H. L. Storke. The report of the operations of the company for the year ending Dec. 31 showed: Gross earnings, $197,476.96; expenses, $202,304.84; net loss, $4,827.88. Compared with the year 1890 there was a decrease in gross earnings of $22,019.79; increase in expenses, $34,303.52. The cost of the conduits for the underground wires was $27,877.05 up to date. To complete the work in Albany and to provide a new switchboard for the central office at Saratoga will probably take the net earnings for the current year. Manager Uline is in hopes that the new building will be ready for occupancy by August. The new switchboard for the Albany office has been ordered of the Western Electrical Company, New York, and is now being constructed. It will be a full multiple switchboard equipped with all conveniencies and improvements. The suit of the company against the Watervliet Turnpike and Railroad Company is still in progress. The Supreme Court at the general term Sept. 8, 1891, gave a unanimous decision in favor of the telephone company. An appeal from this decision was made to the Court of Appeals, where the case is now pending.

President Daniel F. Lewis and Director Bliss, of the Brooklyn City Railroad Company, recently returned from an extended tour through some of the principal cities. They were inspecting electric and cable roads, with a view to finding which was the best system in use. Mr. Lewis, in an interview in the Brooklyn *Citizen*, stated: "We first went to Pittsburgh and through the works of the Westinghouse Electric Company. This occupied five hours, then we took in the Westinghouse engine works, over the lines of a road equipped with the Westinghouse motors and through the power station. At Chicago we saw the cable in operation in all its glory, then we left for Milwaukee. We went through the Allis Engine Works, probably the largest in the country, employing 1,500 hands. Minneapolis was our next point, and we examined the power station there. Next came St. Paul, and there we were put in the hands of Thomas Lowrey, the great railroad magnate. He introduced us to the great power stations of his system, and then we left for Chicago again, where we saw the new station, not completed. The engines are in a space 25 × 100. On Sunday we rested because Mr. Bliss had taken cold, but at night we started for Cleveland. We saw the Short Electric Works, or the Brush Works, if you choose, for all the Brush materials are made there. Then we went to Rochester and took in all the railroad power stations there, and at six o'clock at night we started for Utica, remained a short time, and next found ourselves in Schenectady, where we inspected the Edison works, which cover immense space and where generators are turned out at a lively rate. Boston was our next stopping place. We went through the works of the Thomson-Houston company, where they turn out $50,000 worth a day of generators and electric equipments. The new station at Cambridge attracted our attention for a day, then we went back to Boston and I gave an order for 250 car equipments. We devoted a day to the plans of our new station to be located at Fifty-second street. In all my travels I saw nothing better than the trolley. On Decoration Day we will take the steam off to Fort Hamilton and our South Brooklyn division will likely be electrified by the Fourth of July. On the Second avenue line we will have a new feature in the way of big open cars, so that the summer tourists will not have cause to grumble." L. H. H.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
927 CHESTNUT STREET, PHILADELPHIA, March 5, 1892.

Pedrick & Ayer are very large manufacturers of hoists used in electric light stations.

The Novelty Electric Company will have a new line of goods to offer the trade very shortly.

J. W. Parker & Co., sole agents for the Ball engine for Philadelphia, report business as entirely satisfactory.

H. T. Paiste, the well known switch manufacturer, of this city, is about to introduce to the trade some new goods in this line.

The Star Electrix Company, we are informed, is putting in special machinery with the expectation of doing an increased business.

Mr. Arthur L. Bosley, president of the Pennsylvania Electric Engineering Company, was married recently to Miss May Turner, of this city.

L. F. Siefert's Sons are extensive dealers in second hand engines, motors and dynamos, and report business in their line as being very active.

Vallee Bros. & Co. report meeting with an active demand for insulated joints and fuse block, and state that business in their line is fairly good.

Gill & Co. report sales for last week in their class of specialties as very encouraging. They deal extensively in globes for all descriptions of electric lighting.

Alfred F. Moore, well known through this territory, is dealing extensively at present in his weather proof wire. He is also manufacturer of flexible cords and cables.

W. H. Weston & Co. manufacture what is known as the Weston quick break switch, adapted for high voltage currents. It is made in sizes of from 25 to 1,000 ampères.

Pepper & Register.—This firm of electrical engineers is making a specialty of electric railways and lighting plants, and reports some heavy contracts during the last month.

Queen & Co. are meeting with an active demand for their different instruments in the electrical business. They report business for the last week as being very encouraging.

T. Yearsley deals in second hand dynamos and supplies for municipal and private work, and states that his business for the past week has been as good as could be expected for this season of the year.

The Century Pottery Company is making a specialty of odd shapes in the porcelain line, besides manufacturing rosettes, cut-outs, branch or line blocks and everything that is used for electrical work made of porcelain.

The Moore & White Company are extensive manufacturers of friction clutches and clutch pulleys, also cut-off couplings. Those in need of this class of goods will find it to their advantage to correspond with the above concern.

The Cutter Electrical and Manufacturing Company is meeting with pronounced success, and reports that its business far exceeds expectations, and that the way the trade has taken hold of its specialties is very gratifying.

The Northern Electric Light Ordinance Vetoed.—Mayor Stuart has vetoed the Northern Electric Light Company's ordinance and is receiving the encomiums of all fair-minded citizens. This is believed to be a set-back for the trust.

Thos. H. Dallett & Co., manufacturers of the Billberg electric motor and generator, are also manufacturers of electrical hoists, electrical drills and special motors. They guarantee high efficiency, best mechanical construction and no sparking.

The electrical section of the Franklin Institute held a meeting Tuesday evening last. The following papers were presented: "The Use of the Constant-Shunt Method for the Measurement of Continuous Currents," by Clayton W. Pike; "Cerebro Radiation," by Prof. Edwin J. Houston.

The Heisler Electric Company, well known manufacturers of the long distance series incandescent lighting apparatus, would call attention to its several points of merit; namely, self containing, automatic regulation, brilliant light, great efficiency, reasonable first cost and economy of operation.

The Philadelphia Electric Club.—A meeting of the organizers will shortly be called. In the meantime they will be pleased to hear from parties who have not so far sent in their names. About 200 have so far been heard from, and there is every prospect that the club will be organized with a large charter membership and will be an unqualified success from the start.

The S. S. White Dental Company, sole manufacturers of the Pratz acid gravity battery, have been making some tests with their battery in order to prove its efficiency, and, as far as they have gone, report that it has fully come up to expectations. The manufacturers expect to give the electrical public the benefit of these investigations, as it is believed that the Pratz will play a very important part in the electrical business.

William G. Marks, president of the Edison Electric Light Company, has submitted an ordinance to Mayor Stuart for suggestions and criticisms, which provides that the company shall have the privilege of laying conduits on the streets between the two rivers and South and Callowhill streets. The company offers the city 150 miles of conduit free for the privilege. This work will cost the company $250,000, or about one-quarter the entire sum to be spent in laying the conduits

To Consider the Trolley.—A special meeting of the railroad committee has been called for Monday afternoon of next week to consider the ordinances granting permission to the Traction Company to propel its cars by the trolley system upon many streets of the city. The meeting will be held in Select Council Chamber at one o'clock, and the committee will be prepared to hear from property owners and others interested in rapid transit, or who may be affected by the introduction of the trolley.

Dissolution of Partnership.—The partnership heretofore existing between Arthur L. Bosley and Lewis R. Schultz, under the firm name of the Pennsylvania Electric Engineering Company, was dissolved March 4, by mutual consent. All debts due to the said partnership are to be paid to, and all liabilities of the same are to be discharged by their successors, the "Pennsylvania Electric Engineering Company" (incorporated—capital $25,000), by whom the business will be continued as formerly, at Penn Mutual Building, this city. W. R. W.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass. March 5, 1892.

The Shipman Engine Company, of Boston, is having many calls for engines for small isolated electric light plants.

Albert and J. M. Anderson are doing a constantly increasing business in the well-known Boston trolleys and also in their Etna insulators.

The Dow Adjustable Light Company, Boston, is selling a large number of very handy devices for adjusting incandescent lamps to any height desired, for which purpose they are unsurpassed.

The West End Street Railway Company has had during the past week more snow to fight than at any time this winter, but managed to run its cars with comparatively little delay, owing to the facilities for keeping the tracks clear in the shape of powerful snow plows, sweepers, etc.

The Consolidated Electric Manufacturing Company, Boston, is carrying the largest line and variety of electric and combination fixtures of any house in New England, and large consignments of these goods are constantly being received. Mr. Bibber reports business in this department particularly active.

The Curtis Regulator Company makes a specialty of balanced steam traps, steam and grease separators, damper and pressure regulators, all of which have stood the test of years, and their popularity is attested by the many hundreds in use in various parts of the country and by the increasing demand for them.

C. A. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, March 5, 1892.

The Cook County Abstract Building, near the Chicago City Hall, is being wired throughout with Simplex braided rubber wire furnished by George Cutter.

Dr. Cushman, who as he modestly puts it "claims the invention of the telephone," has been spending some days in Chicago in the interest of the lawsuits now pending both in Illinois and in the adjoining States.

The Randolph Daisy Fan Motor is one of the forerunners of the coming summer, and even at the present day makes a long-winded impression on the casual observer. It has a number of very good features, of which Mr. R. J. Randolph is proud.

American Bell Telephone Company.—The first long distance telephone line between Chicago and New York will be completed within a year and it is expected that more than 8,000 telephones in Chicago will be replaced with copper metallic circuit instruments by the use of which any sound can be transmitted for thousands of miles with perfect distinctness. These improvements will cost the American Bell Telephone Company and its auxiliary corporations several millions of dollars.

Mr. Charles H. Davis, consulting and mechanical engineer, of this city, has issued a neat little folder called "Facts and Figures Interesting to Electric Railroad Men." It contains tables giving the cost of electric roads, the number of cars required for various speeds when running on five minute headway, operating expenses, etc., etc. These tables will be found to contain a great deal of information for street railway men, who are either at present operating their lines by electricity, or who expect to do so in the near future.

Dr. Lyman D. McIntosh, the founder of the McIntosh Battery and Optical Company, died on March 1, of heart disease. He had just gone South to give a series of scientific lectures before a Chautauqua society, when he was called away quite suddenly. He was a well known figure in Chicago medical circles, and his work in divising electro-medical appliances is known throughout the country. The variety of electrical apparatus made by him has grown steadily during the past ten years, and several of the latest devices were exhibited at the Brotherhood ball only a few days before the doctor's death. He has always stood out as one of the few makers of electro-medical goods who really work from a scientific standpoint, and his work in the dental and optical lines only made him the more eager student of the use of electricity in treating certain diseases.

A Great Electrical Plant to Be Established.—The Siemens & Halske Electric Company, of Berlin, which has constructed nearly all the ocean cables, and which has works in London, Berlin, Vienna, and Belfort, France, is about to establish works in Chicago. Articles of incorporation for the Siemens & Halske Electric Company have been filed with the Secretary of State at Springfield by O. W. Maysenberg, Edwin F. Bayley and Otis H. Waldo, the two latter being the attorneys in the matter. The incorporators met recently for organization and elected O. W. Meysenberg president, A. W. Wright secretary, and Arnold von Siemens, George William von Siemens, O. W. Maysenberg, A. W. Wright and Alexander von Babo, directors. The plan of this company, it is stated, is to spend $500,000 in the construction of a temporary plant, which will be operated in connection with that of the Wells & French Company, of which Mr. Maysenberg is president. In the construction of the permanent plant it is said from $3,000,000 to $5,000,000 will be invested. Eventually it is expected to make this plant larger than any of those now operated in Europe. The new company will have the advantage of the $40,000,000 capital of the projectors, and, with the large number of valuable patents and applications for patents which it now has in the United States, its promoters say, will be able to make itself a formidable competitor in the electrical field.

F. DE L.

ENGLISH NOTES.

LONDON, Feb. 24, 1892.

Lane-Fox Distribution Patent.—The action brought by Mr. Lane-Fox against the Kensington and Knightsbridge Electric Lighting Company, which has been pending for nearly two years, came before the courts on Tuesday. Mr. Lane-Fox, it will perhaps be remembered, claims to have covered, by a patent dated 1878, the system of parallel distribution in conjunction with secondary batteries as "reservoirs of electricity."

City and South London Railway.—The City and South London Railway Company has for the past year been harassed by an action for the recovery of damages for an alleged nuisance caused by the working of its generating plant. At one time it threatened somewhat serious consequences to the company, in as much as it was mildly suggested that the only certain way of mitigating the nuisance would be for the company to remove its entire plant for a distance of 20 or 30 yards, and there was no guarantee that the judge would not take this view of the matter. In the result, however, he decided that the company had done all that could be reasonably expected of them and gave judgment, awarding the comparatively small sum of £50 damages.

Municipal Electric Lighting.—The figures for the past half year's working of the Bradford municipal station are of a very satisfactory character. The net profits, after deducting sums from the gross revenue for interest and depreciation, sinking fund, etc., amount to £971. The total loss on the first four half years' working is £2,157, so that after deducting the profit of £971, there still remains a loss of £1,186, which will doubtless be wiped off within the next year. As coal at Bradford only costs 7s. 10½d. per ton delivered at the works, one is not surprised to hear that the cost of coal per kilowatt hour metered is only about ¼d., and that coal being so dirt cheap some nine pounds is used per horse power hour.

Errors in Telegrams.—There has recently been a lengthy and acrimonious discussion in the daily press on the subject of what the public consider to be stupid blunders in telegrams. A small proportion of these blunders are doubtless due to carelessness on the part of the operators, but it is almost certain that if the public wrote their telegrams more legibly, worded their messages more clearly and did not telegraph so unnecessarily, the percentage of error would appreciably diminish. Very few practical telegraphists took part in the discussion, but one of the few who did contributed what was perhaps the most important item of information, viz.: that the experience in this country is that the speed of sending is far greater than the speed of receiving, the result is that the unfortunate man on whom the burden falls of translating the "sounder" ticks into Anglo Saxon has very often to fill up the blanks by the aid of an ingenious imagination.

Electric Light in Theatres.—The London County Council has just issued a set of rules with regard to the use of electric light in theatres and other similar places of entertainment. These rules are not unduly strict, but should they be rigidly enforced would necessitate alterations in the majority of our theatre installations involving no small expenditure. This is due to the fact that one of the first places into which the electric light found its way in this country was the theatre and in consequence nine out of ten of these installations are very much below our present standard of excellence. These rules demand that there shall be at least three totally separate circuits in every theatre. No sub-circuit is to carry more than 65 ampères and no flexible circuit more than 10 ampères. The conductors are to be of such a cross section that they do not heat to a higher temperature than 150 degrees F. when double the normal

current is passing through them. Nothing but pure vulcanized rubber is to be used as an insulating material without special permission. The insulation resistance of any theatre installation when all the switches are turned on and all the lamps and motors removed is to be such that with the normal working pressure applied to it, the leakage current shall not exceed $^1/_{15000}$ of the maximum current required. This rule is not to justify a lower insulation than 5,000 ohms, or to require a higher insulation than five megohms. There is a curious proviso to the effect that no transformer is to be used which heats to more than 130 degrees F. under normal conditions.

London Telephone Service.—The special general meeting of the London Chamber of Commerce to consider the telephone question, which was held on Monday, was very largely attended, and is likely to carry considerable weight with the authorities concerned. The chairman, Sir A. K. Rollit, opened the proceedings with a speech very much to the point. Despatch, he said, was becoming day by day more than ever an element of business, and it had now become a question whether, considering the important part played by the telephone in facilitating business, our telephonic system was the best possible. His own experience was that both in the States and on the continent the telephone service was cheaper and more efficient than in the United Kingdom. Compulsory powers were asked for by the telephone companies, but before these were granted to them he thought the commercial community ought to make sure that the interest of the public would be considered, at least as much as that of the shareholders. There were several manifest advantages in state control of our means of communication, but if that idea were carried out he thought there ought to be some assurance that telephone receipts would not be too largely devoted to revenue purposes instead of cheapening the service. On the whole the meeting deprecated the idea of asking the government to undertake the telephone service of the country. The Duke of Marlborough, who is connected with the company which labors under the disadvantage of having no interurban trunk wires, ingenuously argued that the government should undertake the *interurban service*, as that mainly affected the telegraph receipts. He thought it was hopeless to expect Parliament to confer compulsory powers on purely private trading concerns. Col. Raynsford Jackson (managing director of the National Telephone Company) made out a good case on its behalf. In the provinces, where way leaves were cheap, he pointed out that telephone subscriptions were low. In London, where way leaves cost 30s. per subscriber, and where, owing to the difficulty of obtaining leaves, it was often necessary to run one and one-half to two miles of wire, instead of one mile, subscriptions were high. He also pointed out that the government tax of 10 per cent. on the gross receipts only left the telephone company £18 out of £20 exacted from the London subscribers. As regards the government taking over the interurban lines, his company was of opinion that if they took anything they ought to take over the whole system. The National company, he said, had 20,000 miles of trunk wire in operation, over which 10,000,000 messages passed per annum, costing on an average one penny apiece. It was finally agreed to appoint a deputation to wait upon the Postmaster-General, urging upon him the supreme importance of the government bringing in a General Powers bill affording facilities for the development of the telephone service all over the country. In spite of vague verbiage there is no disguising the fact that we shall soon have to decide whether the government is to take over the telephone system, or whether the telephone companies are to be given compulsory powers. Neither course seems to commend itself to the general public; hence vague recommendations.

News of the Week.

THE TELEGRAPH.

Orange, N. J.—Hereafter the Postal Telegraph Company will keep its office in Orange open all night.

Mr. Clarence C. Ramsay, of the Western Union Telegraph Company office, Bangor, Me., has resigned his position and gone to Canso, N. S., where he has accepted a position with the Bennett-Mackay Cable Company.

The Commercial Union Telegraph Company, of Maine, has organized with the following board of officers: H. S. Osgood, president; E. K. O'Brien, vice-president; Albion Little, treasurer; S. L. Larrabee, secretary and attorney.

Burlington, Vt.—The Commercial Union Telegraph Company has secured control of the line operated by the Great Western Telegraph Company from Plattsburgh through the Adirondacks to Malone, and possession has been taken by the new owner.

St. Johnsbury, Vt.—At the annual meeting of the Vermont International Telegraph Company the old board of officers was re-elected. They are as follows: Franklin Fairbanks, of St. Johnsbury, president; George W. Hendee, of Morrisville, secretary; E. A. Silsby, of St. Johnsbury, treasurer and general manager.

THE TELEPHONE.

Atlanta, Ga.—Work will be at once commenced on a direct telephone line from Atlanta to Macon.

Bell Telephone Instrument Statement.—The Bell Telephone instrument statement for the month ending Feb. 20 is as follows: Instruments, 7,931; increase, 1,859; returned, 5,070; increase, 1,794; net output, 2,861; increase, 65.

Interesting Telephone Statistics.—General Superintendent E. B. Baker, of the Southern New England Telephone Company, recently made public some very interesting statistics relative to the telephone system in Connecticut. It is in the form of a report and shows that during the past year local connections to subscribers have cost less than postage on a letter and answer, being a fraction under four cents. The average number of local connections which have been made daily during the year by the telephone company is 23,100. The total number of circuits is 2,979; total mileage of wire, 7,434, divided as follows: miles of exchange wires on poles, 5,187; on building, 145; underground, 2,026; submarine, 76. The company employs 236 persons. Of this number 87 are day operators, 21 night operators, and the remainder employed in various capacities. The total number of stations in the State is 5,702. Distributed in various parts of the State are 142 pay stations, comprising all the cities and towns in the State. The total miles of poles is 1,790, and of toll wire is 2,993. The average number of daily local connections is 23,100, and the average cost of each local connection to subscribers is a fraction under four cents. The average number of daily toll connections is 851.

THE ELECTRIC LIGHT.

Morrison, Colo., is soon to have electric lights.

Hiram, O.—The question of electric lighting is being agitated.

Constantine, Mich.—The city is to have an electric light plant, Heisler system.

The New Electric Light Plant, at Wheeling, W. Va., it is expected, will be ready for operation by April 1.

Jefferson City, Mo.—The Mayor has called a special election to vote on the question of electric lights for this city.

Manchester, Conn.—A petition is in circulation asking the town to appropriate money for an electric light plant.

Monticello, Ill.—The Decatur Electric Light Company is to take out a franchise and put in an electric light plant in Monticello.

Far Rockaway, Long Island, N. Y.—A company has been formed with a capital of $25,000 to established an electric light plant at Far Rockaway.

Eagle Grove, Ia.—The City Council, it is stated, has declared in favor of electric light, and a plant costing about $20,000 will be put in by Eastern capitalists.

New Carlisle, Ind., wants an electric light plant. The question has been favorably considered by the citizens, and several communications have been received from companies wishing to locate there.

Freeport, Long Island, N. Y.—The citizens have held a public meeting to decide upon the question of electric lighting, and the general sentiment was in favor of the same, but no definite action has yet been taken.

The Davenport (Ia.) Electric Light and Power Company has added a new Thomson-Houston dynamo to its plant, having a capacity for 1,350 incandescents, and another of 650 light capacity is being installed.

Cincinnati, O.—Sealed proposals will be received until March 22 for an electric light plant complete, dynamo, engine, lamps, wiring, etc., to be furnished and set in place ready for service at the new Price Hill pumping station.

Wakefield, Mass.—The petition of the town of Wakefield for special legislation to empower it to establish an electric light plant was again heard before the committee on manufactures this morning, and the matter was again continued.

Boone, Ia.—The Council has granted an extension of 20 years to the franchise of the Boone Electric Light Company, and the business will be enlarged by the addition of a $30,000 arc light plant and the city streets will be lighted by electricity.

The Visalia Electric Light Company, of Visalia, Cal., has levied an assessment of 10 per cent. to put in a new engine and arc-lights for streets. Machinery has been ordered from the East. The present plant is inadequate to supply the demand for the incandescent light.

Chicago, Ill.—Sealed proposals will be received until April 2 for the general electric lighting of the grounds of the World's Fair Exposition and the buildings thereof, in accordance with plans and specifications on file, copies of which may be had on application to D. H. Burnham, 1,143 The Rookery.

Augusta, Ga.—Chairman McCarthy, of the Lamp Committee, has received bids for the electric lighting of the city from the Thomson-Houston company and from the Augusta Electric Light and Power Company, but the bids have been left open and in the committee's hands, and will not be considered final.

The Southern Electric Company, of Baltimore, Md., of which J. Frank Morrison is president, has purchased the plant and franchises of the International Telegraph District and Construction Company, and, it is stated, will reorganize that company and put it into condition very shortly to do lighting by the arc and incandescent systems and supply power to manufacturers.

To Be Lighted by Electricity.—The following towns are moving in the matter of electric lighting: Girard, O.; Avon, Ill.; Rushville, Neb.; Albion, Ind.; Clear Lake, S. Dak.; Lacon, Ill.; Springport, Mich.; Wapakoneta, O.; Wellston, O.; Bellefontaine, O.; Somerset, Pa.; Atlantic Highlands, N. J.; Quakertown, Pa.; Hollister, Cal.; Dorr, Mich.; Caledonia, N. Y.; Oberlin, O.; Homer, Ill.; Coon Rapids, Ia.

Electricity will be extensively used in the new plant which is being erected in Milwaukee by the Bucyrus Steam Shovel and Dredge Company. The new plant will be equipped and ready for occupancy about July 1. It will be lighted by a combination system of arc and incandescent lights. Many of the power applications will be made by electricity, and electric motors will be largely used for various purposes.

Cincinnati's electric light war still continues and savors considerable of a gigantic combine, in which it looks very much as if the Hickenlooper combination would come out in the lead. The Porkopolis is looked upon at present as the electric light battlefield of the country, toward which the best forces of all the more prominent companies are flocking, eager to close in and force the issue or short circuit the whole deal.

Electricity for Western Montgomery, New York.—A project is on foot, the object of which is to establish an electric light, heat and power plant at Palatine Church which would supply electricity to the five villages of western Montgomery county, St. Johnsville, Fort Plain, Nelliston, Palatine Bridge and Canajoharie. A stock company is being formed with a capital of $75,000, divided into 750 shares of $100 each, and the undertaking is being backed to such an extent that its success is assured, it is stated.

Albia, Ia.—A. R. Jackson, of Jerseyville, Ill., has secured a franchise for electric lighting at Albia, Ia., and is now proceeding with the installation of his plant, which he expects to have in operation within 30 days. He will use Edison incandescent and Thomson-Houston arc apparatus. The Pond Engineering Company, of St. Louis, has Mr. Jackson's contract for complete power plant, including a 14 × 13 Armington & Sims engine, with base; two 60 h. p. steel boilers, Lowe heater, Blake boiler feed pump, Korting injector, tank, pipe work, foundations, furnaces, etc. This plant will be a model one in every way.

ELECTRIC RAILWAYS.

Brazil, Ind.—It is reported that the Terre Haute Electric Street Railway Company is to extend its lines to this city.

Galesburg, Ill.—The directors of the Galesburg Street Railway Company have decided to equip the lines with electricity.

Taunton, Mass.—H. L. Stillman, of Kenyon, R. I., is interested in the proposed electric railway from Providence to Taunton.

The Stillwater Electric Street Railway Company, of Stillwater, Minn., has gone into the hands of Wm. M. Hewitt, receiver.

Dubuque, Ia.—It is stated that the storage battery system in use on the Dubuque street railway is to be replaced by the trolley system.

Steelton, Pa.—The Citizens' Electric Passenger Railway contemplates laying tracks for an electric street railway from Oberlin to Harrisburg.

Kingston, N. Y.—Dr. E. H. Loughran, Robert Wilson, Dr. Charles W. Deyo and others are interested in the proposed electric street railway for this place.

The Springfield (Mass.) Street Railway Company has been granted permission to extend its line into West Springfield, and equip it with electricity.

Kingston, N. Y.—It is stated that the Thomson-Houston company will be interested in the Kingston City Horse Railroad Company, the transfer of whose franchise for $175,000 will be made April 1.

Montreal, Can.—J. X. Perreault has made application to the Mount Royal Park Committee to construct and operate an electric railway around the Mountain Park. He was referred to the Common Council.

Permission will be granted, it is stated, to the Lowell & Suburban Company to extend its electric railway to Chelmsford. The double trolley system will be used, and the extension will be in operation by July.

Concord, N. H.—It is reported that one of the largest electric manufactories in the United States has offered to take the franchise and construct, equip and operate with electricity the proposed railroad from Concord to Rochester.

The Indianapolis & Broad Ripple Rapid Transit Company, of Indianapolis, Ind., has at last been granted a franchise by the county commissioners. It is stated that the company will be reorganized and will start work at once on its electric lines.

A charter has been granted for the Pottsville, Pa., and Minersville Electric Railway. The company starts out with a capital of $100,000. In less than a year, it is predicted, people will be traveling between Pottsville and Minersville on a new electric railway.

To Build Electric Railways.—New York and Knoxville (Tenn.) capitalists have organized the Robertson Southern Electric Underground Railway Company in Knoxville. It is the purpose of the new organization to build about 300 miles of electric railways in East Tennessee in the near future.

The Spokane & Montrose Motor Railway Company, of Spokane, Wash., has closed a contract with the Short Electric Railway Company for electrically equipping three miles of its system and furnishing three cars equipped with "gearless" motors, to replace the steam dummies now in use.

Toronto, Ont.—It is stated that the city has decided to enter into an agreement with the Street Railway Company, which insures an immediate electric service. The city will agree to the trolley system provided the right is given at some future time to insist on a change if a better system is developed.

Rochester, N. Y.—The Rochester Railway Company will complete the equipping of its entire system with electric cars and will also erect a new building in the rear of its present structure on State street. The company is going to introduce a new 400 h. p. boiler to the power house on Centre street.

The Niagara Falls and Suspension Bridge Street Railway Company is circulating a petition among the property owners along its route, asking their consent to allow the company to change its motive power to electricity, and to lay a double track. This change will involve an expenditure of about $150,000.

Cape May Point, Pa.—An electric railway will be built from the steamboat landing at Cape May Point on the Delaware Bay to Sewells Point. The overhead and trolley system will be adopted. Operations will be begun June 15. Among those interested are E. C. Knight, ex-Senator A. G. Cattell, Wm. S. Scull and others. It is stated that the road will cost $100,000.

An electric road seven miles long is to be constructed in Waukegan, Ill., by the Waukegan & North Shore Rapid Transit Company. At a recent meeting of the company the following officers were elected: President, Dunlap Smith, of Chicago; vice-president, A. L. Hendee, of Waukegan; secretary, Homer Cook, of Waukegan; treasurer, C. E. Simmons, of Chicago; executive committee, Charles E. Simmons, Homer Cook, F. I. Bennett, H. B. Cragin and Dunlap Smith.

The equipment of the electric railway in Yonkers, N. Y., is being pushed forward rapidly, it is stated. The contracts have been awarded with heavy forfeitures attached in case of failure to complete the same by March 25 of this year. The overhead appliances will be constructed by the Thomson-Houston company. The electrical equipment of the power house has been awarded to the Edison company. The steam boilers will be furnished by the Sterling company. There will be two steam engines of 125 h. p. each, of the latest improved Ball & Wood type. The John Stephenson company is building the first four car bodies, and the motor trucks to be attached to them are being built by Osterheld & Eickemeyer.

GENERAL APPLICATIONS OF POWER.

The Denison Light and Power Company, of Denison, Tex., will erect a power circuit this spring, and expects to have the same in operation April 1. A 500-volt current will be used.

The Columbian Electric Transmission Company, of Chicago, Ill., has been incorporated with a capital stock of $50,000, for the purpose of transmitting electric power on a large scale. The incorporators are Gustav Monrath, Charles G. Armstrong, and Clarence Giggs, all well known Chicago electricians. The company proposes building a large power house on the Illinois River at Marseilles, and later at other points, for transmitting power to Chicago. It also proposes to transmit 1,500 electric horse-power to exhibitors at the World's Fair, and has not yet decided whether the alternating or direct current will be employed. The scheme was formulated last summer, and has been frequently discussed at the Chicago Electric Club, and all were satisfied of its feasibility. Capitalists are interested in the scheme, and there is no doubt that the power house and line will be constructed. One-fourth of the capital stock has already been subscribed.

LEGAL NOTES.

Suit has been brought by the Builders' Insulating Tube Company, of Lynn, Mass., and the Indurated Fibre Industries Company, against the Interior Conduit and Insulation Company, Mr. E. H. Johnson, president, for infringement of patents covering the making of pipes, or paper tubing, to carry electric wires. The plaintiffs in this action announce that they will also bring suit against users of the pipe in question.

An Electric Lamp Patent Upheld.—The United States Court has just handed down a decision in the suit of the Brush Electric Company against the United States Electric Lighting Company, upholding the patent of Charles F. Brush, obtained in 1879 for the double carbon lamps, and granting the complainant a perpetual injunction. Commissioner Shields has been appointed master to find out what profits are due the Brush company.

An Injunction in Favor of the Western Union.—An injunction has been granted by Judge Ingraham of the Supreme Court, restraining the Western Union Telegraph Company from

paying royalty on the leased lines of the Montreal Telegraph Company. The Montreal Telegraph Company leased its lines to the Great Northwestern Telegraph Company, of Canada, for 10 years. The consideration was 8 per cent. on the capital stock of $2,000,000, or $160,000, which was payable quarterly. The Western Union Company guaranteed the payment of the royalty, and, as the Montreal company has not paid, the Western Union has been compelled to hand over $160,000 a year for this money.

PERSONAL.

Dr. F. F. Randolph, secretary and treasurer of the River and Rail Electric Light Company of New York, died Feb. 24.

Mr. Norman Marshall, who has been connected with the Star Electrix Company since its inception, has retired from that company and will embark in business in Boston, his old home.

Mr. C. R. Huntley, ex-president of the National Electric Light Association, has been made a director of the Cayadutta Electric Railway Company, which has recently been incorporated to build an electric railway from Gloversville to Fonda, N. Y.

William H. Dillon, a well-known telegrapher, died of consumption in Philadelphia, Sunday, March 6. Mr. Dillon was formerly a chief operator in the Western Union main office in that city, and afterward connected himself with the Baltimore and Ohio Telegraph Company. For the last three years Mr. Dillon had charge of the *Ledger's* special wire service.

Messrs. Richard H. and William H. Edmonds, formerly proprietors of the *Manufacturers' Record,* published in Baltimore, have retired from the ownership of the paper. These gentlemen have hosts of friends not only in the South, but in every part of the country where the journal which they have published has circulated. By their efforts they have built up an extensive medium and one of the best class journals published, and their successors have come into possession of a valuable property.

MISCELLANEOUS NOTES.

A Correction.—In Mr. Schlesinger's article on the transmission of power which appeared in our columns last week the expression "horse power average," which occurs a number of times in the last column of the article on page 155, should read in each instance "horse power available."

The California Electrical Society, at its annual meeting held at San Francisco recently, elected the following officers for the ensuing year: President, George P. Low; vice-president, C. O. Poole; treasurer, O. Brooks; secretary, W. Crossett; executive committee, E. A. Roe, C. T. Ryland, Jr., R. B. Elder.

Losses by Fire.—The People's Electric Light and Power Station at Moline, Ill., including sixteen valuable dynamos and other machinery, was destroyed by fire recently, together with wheelhouses and other property belonging to the Moline Water Power Company. The loss to the Electric Light and Power Company is $30,000 and to the Water Power Company about $20,000. The total insurance is less than $20,000.

For a New Electric Fire Alarm.—The Board of Aldermen of Winston, N. C., has closed a contract with the Gamewell Electric Fire Alarm Company, of New York, to put in a system in this city. The contract calls for the completion of the system by Oct. 1 next, at which time the new market-house will be completed, in which building a handsome and conveniently arranged department will be fitted up for Winston's fire company, which will be reorganized and greatly strengthened. The city will pay for the system by giving two negotiable notes of $1,000 each, and made payable Jan. 1, 1893. One note will bear six per cent. interest, while the other will be without interest.

The Electric Club, of Louisville, Ky., was formed recently by electricians of the city, who at a meeting called for the purpose of organization elected Mr. Campbell Scott temporary chairman and Mr. G. S. Maxwell temporary secretary. A constitution and by-laws were adopted, and it was decided to hold meetings weekly on Monday evenings. The Electric Club of Louisville was chosen as the name of the organization. Mr. Campbell Scott was elected president; Charles Smith, vice-president; W. Lea, secretary; H. Donigan, treasurer; E. Willard, G. S. Maxwell, H. Donigan and M. Ruthenberger, directors. The object of the club is to advance the interests and increase the knowledge of the electrical men of the city by means of personal intercourse and discussions.

Industrial and Trade Notes.

The Richmond Granite Company, of Richmond, Va., makes a specialty of furnishing engine beds for electric light and power plants, and furnishes estimates for the same on application.

The New England Butt Company, of Providence, R. I., has received from the management of the Augusta (Ga.) Exposition the diploma and medal awarded them in September, 1891, for the best braiding and winding machinery.

The John Simmons Company, of 110 Centre street, New York, manufacturers of steel and iron poles and brackets for electric railways, has just shipped an order for 400 bracket arms to the Atlanta & Chattahoochee Electric Railroad Company, of Atlanta, Ga.

The Sebastian Lathe Company, of 41 Central avenue, Cincinnati, O., has sent out a neat new catalogue and price list for 1892 which contains a large amount of descriptive matter and a number of illustrations of machinery, tools and supplies which the company manufactures.

Mr. F. S. Blackall, 126 Liberty street, New York, has been appointed agent in New York and vicinity for the Carpenter Electric Heating Company's line of specialties and has on exhibition at his office a beautiful line of electrical cooking apparatus, including sad irons, soldering iron, etc.

The Electric Appliance Company, of 242 Madison street, Chicago, has completed arrangements to represent the Cutter Electrical Specialty Company, of Philadelphia, in the West, and will hereafter carry a full line of the Cutter portables, reflectors, flexible brackets, etc., for which a very large demand has already been established.

The Proctor & Gamble Company, of Ivorydale, near Cincinnati, has decided to change its present plan of power transmission throughout its buildings to the electrical system. The company proposes to install several 100-h. p. Jenney generators and motors to drive various kinds of machinery in its factory. The first change will be made about the middle of March.

The Eddy Manufacturing Company, of Windsor, Conn., has issued a new catalogue containing some very fine illustrations of its motors and dynamos, together with a number of half tone plates showing the Eddy motors in operation in a variety of manufacturing industries. Among these may be mentioned printing offices, boot and shoe factories, jewelry factories, etc.

The Great Western Electrical Supply Company, of Chicago, is having remarkable success with the new Hercules tape which was placed on the market some two months ago. The number of orders received and the praise that is given to the tape wherever used shows that it is taking its proper rank on the market, as a strictly first-class, high grade tape. It is manufactured in white, black and pure rubber.

The Monthly Bulletin of the railway department of the Thomson-Houston Electric Company for February contains not only a complete list of all the electric roads operated by the Thomson-Houston system, but also extracts from the rules and regulations for motormen of the West End Street Railway in Boston. These last are reprinted for the benefit of managers of electric street railways and are intended for the guidance of motormen operating cars equipped with Thomson-Houston motors.

S. N. Blake, of Elmira, N. Y., is installing for Messrs. J. N. Adams & Co., in their large new store, Buffalo, N. Y., 100 Ward arc lamps and 200 incandescents on two Mather 600-light dynamos belted direct to 60-h. p. engines of the Phœnix Iron Works Company, Meadville, Pa. Several motors ranging from 2 to 10 h. p. will be operated from these circuits also. This will be the largest plant of its kind in Western New York, and, it is stated, decidedly novel in construction. The plans were made by Jesse M. Smith, Detroit, Mich.

The Union Electric Company, of 45 Broadway, New York, manufacturers of storage batteries, has issued its catalogue for 1892, which illustrates and gives a description of the high voltage cell which the company manufactures. This company is the sole licensee, under the patents of the River and Rail Electric Light Co., for the States of New York (excepting Long Island), Pennsylvania and West Virginia, and holds the exclusive right to manufacture for the River and Rail Electric Light Company, all batteries to be used or sold by them throughout the United States.

The True Blue Marble Company, of Rutland, Vt., will replace its mill, lately destroyed by fire, with an iron building, and has placed the contract with the Berlin Iron Bridge Company, of East Berlin, Conn. The building will be composed entirely of iron and marble, and will be 80 feet in width by 254 feet in length, the side walls being of iron and marble and the roof of corrugated iron. Not only the entire building will be of iron, but the framework inside for carrying the gang saws, shafting, etc., will be of iron, so that there will be no woodwork about the building in any way to take fire.

The Electrical Supply Company, of Chicago, is manufacturing a full line of electric railway material and has issued a comprehensive catalogue covering this branch of the work. The company states that those in charge of the Railway Department are men of varied experience in this particular field and keep closely in touch with the increasing demand for practical and economical devices. One of the specialties is Shield brand moisture-proof feeder wire; that it is appreciated seems evident from the numerous orders from railways and railway contractors. The Boston trolley, for which the company is the Western agent, and Wood's self-locking pole ratchet continue in active demand.

The Light of To-Day.—The following appeared in a recent issue of the New York *Christian Advocate:* "What an awakening there is among good people generally on the question of comfort in their homes and brightness and beauty in their surroundings. This is as it should be, but is not as it used to be. The world moves and the age is a progressive one. We no longer depend on the candles of our fathers, but enlighten our evening by electric sparks that leave gas and tallow in oblivion; and by the use of the wonderful Frink reflectors diffuse in our large assembly rooms and large halls and church buildings a sweet, delightful illumination that greatly adds to the enjoyment of modern life." These reflectors are manufactured by I. P. Frink, 551 Pearl street, New York.

Apropos the Buffalo Convention, it is worthy of note that the Buffalo Street Railway Company, consolidated lines, have just ordered three 24-inch Underwood cotton leather belts for their power station. These are in addition to the four cotton leather belts of same make and size now running at this station. These and other Underwood belts running in Buffalo were inspected and found to be doing exceedingly well. The Iroquois and Broezel hotels are equipped with them, and guests of these houses who were attending the convention were shown the practical working value of Underwood belting. The Buffalo belts were purchased through the Engineering Equipment Company, who have full control of the Underwood trade in New York State, from their offices, 143 Liberty street, New York City.

Mr. H. Ward Leonard's method of electric motor control, which he exhibited for the first time at the Montreal Convention, and upon which he has recently secured broad patents, is meeting with great favor, it is stated, at the hands of electric elevator people. Mr. Leonard has granted licenses to the Otis, Crane, Hale, Stokes and Parrish and the Whittier Elevator companies, and electric elevators operated under Mr. Leonard's method are being rapidly introduced by these companies. This elevator is said to be very popular with the central station managers, as it uses so small a current in starting up the elevator as to have no effect upon electric lights on the same circuit. By Mr. Leonard's method an electric elevator can be operated from an Edison three-wire circuit, an arc circuit, a railway circuit, or an alternating circuit, which gives it an exceptional flexibility.

The Samson Cordage Works, of 115 Congress street, Boston, manufacturers of braided goods, are building some new braiders for the manufacture of the Samson arc light cord. This has been made necessary on account of the increased demand for this article, which has taxed the capacity of their manufactory. The new machines will differ in pattern somewhat from the old ones and will embody many improvements. The cord manufactured by this concern is made from a fine grade of cotton stock, free from waste, and its tensile strength is said to be very high, so proven from many tests which have been made. It is given a waterproof finish, which increases its durability to a considerable extent and makes it a desirable cord for hanging arc lamps, as well as for trolley and magnet purposes. The manufacturers send samples of this cord in the various sizes to any one applying for the same and also a very complete descriptive catalogue giving prices, etc.

The Interior Conduit and Insulation Company, of 42 and 44 Broad street, New York, in order to meet a demand for a tube that will not disintegrate when placed in cement under tile floors, and in like places be less liable to mechanical injury during the construction of a building, and also be proof against fire arising from external sources, has produced and is now manufacturing an insulated tubing covered or armored with metal. Where electric lighting is to be introduced in a finished building, this brass covered tube will be found, it is stated, especially desirable for and applicable to surface or exposed wiring, and brass covered appliances are furnished to match. The conduit system has been demonstrated to be a practicable, safe and accessible method of interior wiring, and the details of construction have been carefully worked out. There is a possibility, however, of the system being condemned by the careless or ignorant handling of contractors, and in order to assist in procuring all its many advantages the Interior Conduit Company has drawn up a form of revised wiring specifications, which are being sent out to any requesting a copy of the same.

The Berlin Iron Bridge Company, of East Berlin, Conn., is running its works full time, and is very much crowded with orders. Among other contracts which the company has on hand is an iron building 80 feet × 254 feet for the True Blue Marble Company, at West Rutland, Vt.; an iron building 52 feet × 170 feet for the Chester Pipe and Tube Company, at South Chester, Pa.; a boiler shop 68 feet × 201 feet, and a machine shop 72 feet × 184 feet for the Dry Dock Engine Company, at Detroit, Mich.; a boiler shop 115 feet × 370 feet for the Wm. Cramp & Sons Ship and Engine Building Company, at Philadelphia, Pa.; all the iron work, including the beams, girders, roof, etc., for a new building, which the National Fire Insurance Company are building at Hartford, Conn.; an iron bridge boiler house for the Montgomery Furnace at Pt. Kennedy, Pa.; a new casting shop 69 feet × 167 feet for the American Tube Works at Somerville, Mass.; and also a large roof for the new residence of Joseph D. Potts, at Wyebrooke, Pa. In bridge work they are building several bridges for the N. Y. H. & H. R. R. Co., besides a large number of highway bridges in different parts of the country. A large building has just been completed for the Delaware Iron Company at New Castle, Del., and also a large iron building for the Boston & Montana Consolidated Silver and Copper Mining Company, at Great Falls, Montana. The Berlin Company seems to have plenty to do, and is employing its entire force on full time.

N. I. R. Seamless Insulation.—The wires and cables manufactured by the National India Rubber Company, of Bristol, R. I., are now so well known and appreciated by the trade that this company is building a new plant, which will increase its capacity four times. Twenty-five years of experience with india rubber has given the company a thorough and minute knowledge of the manipulation of rubber in all its branches, and its application as insulation for the electric wires is no new thing with them, for 18 years ago they applied rubber covering to wires for their own use, which wires are in use to-day with unimpaired insulation. For a number of years Col. A. C. Eddy and other officers of the company have been experimenting with rubber insulation in conjunction with electrical experts, in the endeavor to produce a superior insulating covering. The Massachusetts Electrical Engineering Company, of Boston, has been associated in these later tests, which have proved that only the best and most carefully prepared rubber compound will make a good and lasting insulation. The N. I. R. insulation possesses high insulating qualities, and is claimed to be less susceptible to the destructive influence of heat, cold, moisture and gases than that used by other companies. Pure lake copper and fine Para rubber are used. The rubber covering is first pressed around the wire in a semi-plastic form, making a seamless covering, considered an important advantage over insulation having a seam on one or both sides. It is then wound with rubber tape and covered with a braided weatherproof outer envelope. The whole insulation is then vulcanized. The wire is made with a black finish, or with a white fireproof finish, as desired. Telephone and telegraph wires, switch cords, electric light and underground lead covered cables are made in all the sizes called for with a standard insulation resistance of 1,000 megohms per mile. A large quantity of these lead covered electric light cables are in use in the New York City subways. Samuel P. Colt is president of the National India Rubber Company, and F. S. Minott is manager of the wire department.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

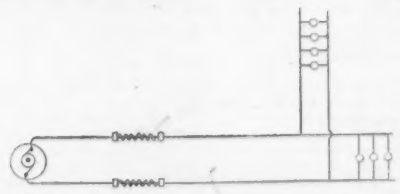
The Mather Electric Motors combine the highest efficiency and workmanship consistent with a reasonable first cost. Perfect automatic regulation of speed from no load to full load. For catalogue and information address E. T. Pardee, agent, 14 Butler Block Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED MARCH 1, 1892.

469,672. Electromagnet; Andrus D. Ayres, of Kalamazoo, Mich. Application filed May 23, 1891. The combination of a plurality of electromagnets provided with a plurality of paramagnetic incasements magnetically separated and bound together, each incasement arranged as an armature for particular magnets, and provided with a suitable commutator, whereby the various magnets are successively magnetized and the united armatures made to partake of the action of the series.

469,706. Telephony; William C. Lockwood, of New York. Application filed Sept. 29, 1891. In a telephonic system, a local circuit embracing a transmitter, a battery, and an electromagnet in combination with a circuit arranged within said local circuit.



NO. 470,014.—FUSE FOR ELECTRIC CIRCUITS.

and embracing an electromagnet and conductors connecting with said local circuit and the line and ground conductors whereby the circuits are grounded. (See illustration.)

469,712. Device for Controlling Electric Motors; Albert L. Parcelle, of Boston, Mass. Application filed March 14, 1891. The combination of a main electric circuit, a double acting contact finger therein, duplex contact plates, one on each side of the central position of said finger, in a branch circuit including the field coils of an electric motor, and a duplex rheostat, one on each side of the central position of said finger, in another branch circuit including the armature of said motor, whereby a movement of the contact finger in either direction from its inactive position throws a full current through the field and a gradually increasing one through the armature in the same direction.

469,723. Underground Electric Conduit; Edward P. Robbins, of Cincinnati, O. Application filed Feb. 24, 1890. A conductor conduit consisting of a trough of rectangular cross section, in combination with a cover, the top edges of the sides being beveled exteriorly and downwardly and outwardly and the cover

having its edges projecting exterior to the outer surface of the sides and beveled to fit the bevels of the sides, and the inner cover edge being enlarged or thickened exterior to the surface of the side and having a plain exterior surface.

469,725. Dynamo-Electric Machine; Elmer A. Sperry, of Chicago, Ill. Application filed Jan. 10, 1890. This invention consists of the combination, in a dynamo, of a rotating shaft with an annular armature, rods passing through the same, a supporting spider for such rods, the rods being flattened at the point or points where the armature coils pass them, and a field magnet.

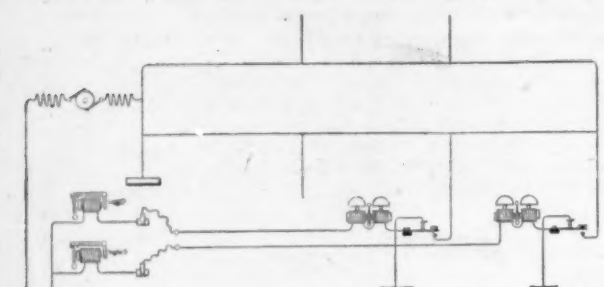
469,745. Non-Interfering Fire Alarm Telegraph Box; Frank F. Loomis, of Akron, O. Application filed Aug. 31, 1891. In a signal box, a signal transmitter and a motor for driving it, in combination with two electromagnets having their cores hinged and in magnetic connection at one end, one of said magnets being fixed and the other free to swing on said hinge and provided with a detent to arrest the signaling mechanism, the opposite ends of their cores arranged to meet, and both magnets arranged to be simultaneously brought in the electric circuit.

469,750. Automatic Trolley-Catch; Stephen A. Shepard and Frederick P. Lang, of Allegheny, Pa.; said Lang Assignor of one-fourth to said Shepard. Application filed Aug. 7, 1891. A trolley-catch comprising, in combination, spring actuated mechanism connected with the trolley and adapted to depress the same, a detachable lock adapted to hold said mechanism, a tripping device actuated by rise of the trolley, and adapted to free said lock, and an alarm signal actuated on motion of said spring actuated mechanism.

469,765. Distributing Box for Cable Systems; Charles H. Wilson, of Chicago, Ill., Assignor to the American Bell Telephone Company, of Boston, Mass. Application filed Sept. 19, 1889. The invention consists of a street vault provided with niches, a distribution box supported in said vault in a niche intermediate of the niches containing the ends of the ducts for the cables, and the wires thereof being connected therein.

469,782. Telephone Transmitter; Joseph Cuthbert Goulding, of Cardiff, Assignor to the Woodhouse & Rawson United, Limited, of London, England. Application filed June 12, 1891. The invention comprises two uprights and a carriage carrying the telephone appliances, adapted to slide between said uprights, and a locking device for locking the carriage against motion at any desired height.

469,792. Electrically Heated Smoothing Iron; Willis Mitchell, of Malden, Mass., Assignor to the Butterfield-Mitchell Electric Heating Company, of Boston, Mass. Application filed May 27, 1891. In an electrically heated smoothing device, a body of magnetic metal affording the heating and smoothing surface



NO. 469,865.—TELEPHONE SYSTEM.

and provided with magnetic studs or cores, in combination with wire coiled about said studs and forming part of an electric circuit.

469,796. Galvanic Electric Plaster; John W. Shults, of Wichita, Kan. Application filed May 16, 1891. A galvanic adhesive plaster for therapeutical purposes, consisting of a plaster compound spread upon a linen or suitable backing and compounded with pulverized carbon, the opposite cells comprising the reverse.y arranged elements incorporated in the plaster compound and having surfaces on a plane of the compound, the conductor wires arranged connecting the opposite elements of the cells and embodied in the plaster compound, and the body-encircling conductor cord arranged connecting the opposite elements of the cells.

469,797. Galvanic Electrical Plaster; John W. Shults, of Wichita, Kan. Application filed June 29, 1891. A galvanic adhesive plaster for therapeutical purposes, consisting of a plaster compound spread upon a linen or other suitable backing, the opposite cells comprising the reversely arranged elements incorporated in the plaster compound, and having surfaces on a plane with that of said compound, the conductor wire incorporated in said plaster arranged connecting said cells, the conductor connecting said cells and extending oppositely from the plaster, and the contact buttons forming the terminal of said extending conductors.

469,799. Electric Locomotive; Thomas L. Willson, of Brooklyn, N. Y. Application filed July 3, 1891. In an electric locomotive, the combination of two pairs of driving wheels arranged close together and an electromotor having opposite friction wheels on its shaft, the wheels entering partially between and resting on friction wheels or surfaces on the respective advancing and following driving-wheel axles, the motor constructed and mounted so that its weight is hung from its shaft, so that it serves to press the friction wheels into tractive contact, and the frame of the motor constructed to engage the bearing boxes of the driving axles to maintain them at the proper distance apart, and to resist the reactive thrust of the motor.

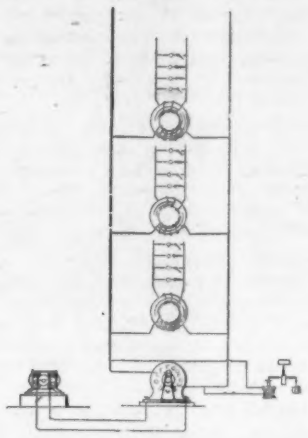
469,800. Electric Meter; James J. Wood, of Fort Wayne, Ind. Application filed Oct. 27, 1891. In an electric meter, the combination, with an electromotor driven by the current to be measured, of a magnetic retarder therefor, consisting of a conducting cylinder revolved by said motor and a horseshoe-magnet interior to said cylinder arranged with its poles facing it in positions at different radial angles, whereby the cylinder in revolving before said poles passes them successively.

469,806. Commutator Brush and Holder; Charles D. Jenney, of Indianapolis, Ind., Assignor to the Jenney Electric Motor Company, of same place. Application filed Jan. 16, 1891. The combination, in a commutator brush, of the brush-head, an opening therein adapted to receive and hold contact-points, ways also in said opening, followers mounted in said ways, and springs attached to said head and said followers, whereby they are adapted to operate upon said contact-points.

469,809. System of Electrical Distribution; William Stanley, Jr., of Great Barrington, Mass., Assignor, by mesne assignments, to the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa. Application filed Aug. 15, 1888. In a system of electrical distribution, and in combination, an alternating current dynamo and converters electrically connected with the main line conductors in multiple arc, and organized to transform the current in the main conductors into currents of less potential and greater quantity in the secondaries, each converter made with a primary coil containing such length of wire exposed to magneto-electric induction that when operated by the dynamo with which it is to be used with its secondary circuit open the electrical pressure and counter-pressure in its primary circuit shall be equal with incandescent lamps or other translating devices in the secondary circuits. (See illustration.)

469,828. Conduit System for Electric Railways; John Edward Waller and Edward Manville, of London, England. Application filed May 13, 1890. A system of distribution and collection of electric current for the propulsion of vehicles, consisting of a flexible conductor supported upon but not rigidly attached to insulators situated widely apart, a rigid collector arm or arms detachably attached to a shank carried by the tram or by a dummy car, the said collector acting on the under side of the conductor and being short enough to lift the conductor free from or with its insulated supports to insure uniform and effective electrical contact upon the collector by the weight of the conductor, and a straining device capable of moving the conductor longitudinally and consisting of a hanging weight and connecting yoke to the next section, permitting passage of underneath collector and maintaining continuous electrical contact between collector and conductor without considerable, if any, pressure from a straining weight upon the collector.

469,856. Telegraph Apparatus for Branch Offices; John B. Hurd, of Red Bank, N. J., Assignor to the Western Union Telegraph Company, of New York. Application filed March 7, 1890. A main telegraph line extending through a central station to an outlying local station and thence back to the central station, an indicating magnet which is irresponsive to telegraph signals and a battery, both placed in said main line at the central station, an earth branch connecting said loop with the earth at the local station, and a key placed in said earth branch for enabling the local operator to signal the central station while he is at the same time in communication with a distant main line station.



NO. 469,809.—SYSTEM OF ELECTRICAL DISTRIBUTION.

469,861. Contact Device for Electric Railways; John C. Love, of Philadelphia, Pa., Assignor to the Love Electric Traction Company, of Chicago, Ill. Application filed June 16, 1891. A car having an upward pressure contact device comprising a pole, a block to which the pole is attached, four arms pivotally connected with the block, grooved wheels mounted upon the free ends of said arms, springs connecting said arms with the block, and stationary parallel rods or wires attached to the car and engaged with the grooves of said wheels.

469,862. Electromagnetic Machine; Robert Lundell, of New York, Assignor of one-half to Edward H. Johnson, of same place. Application filed Aug. 15, 1891. The combination of a disc armature and a double field magnet having a set of positive and negative poles on each side of the disc armature, each set of pole pieces being magnetized by a single magnetizing coil.

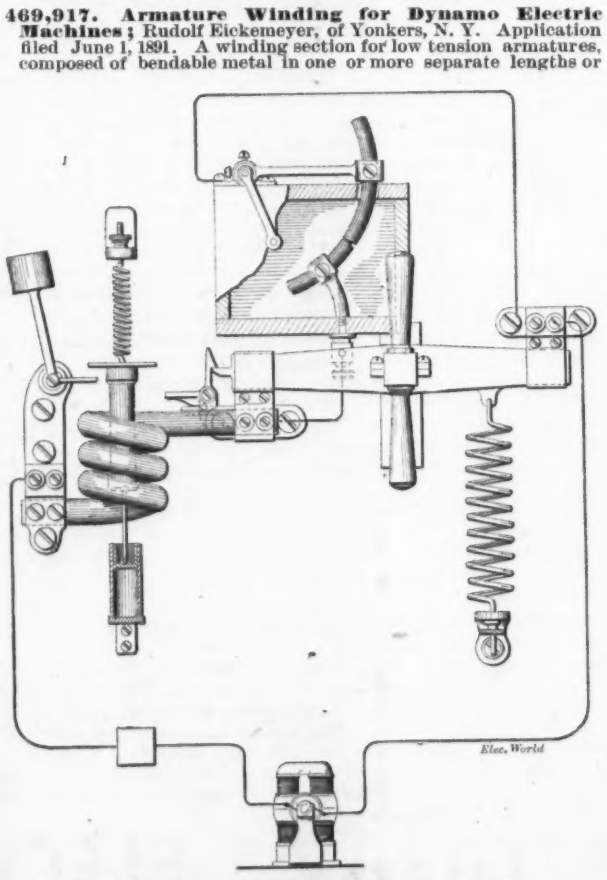
469,865. Telephone System; Thomas W. O'Brien, of Wilkes-Barre, Pa. Application filed Nov. 12, 1890. The combination of an electric generator at a central station, having one of its poles connected to the earth and the other to a normally open signalizing circuit provided with permanent branches extending to two or more sub-stations, indicating apparatuses, corresponding in number to said sub-stations, each such apparatus having one of its terminals connected to earth at the central station and the other to a line extending to a corresponding sub-station, and a normally open key at said sub-station, which when closed connects said line with the common signalizing circuit, and thereby actuates the corresponding signal apparatus at the central station. (See illustration.)

469,873. Apparatus for Illuminating Cars of Cable Roads; Charles E. Scribner and Ernest P. Warner, of Chicago, Ill., Assignors to the Western Electric Company, of same place. Application filed Oct. 13, 1891. The combination, with a moving cable, of a rotary wheel fixed to the car and in contact with the cable, adapted to transmit rotary motion to parts of a mechanism, and a second wheel journaled to the car and adapted to roll upon a rail or plane when the car is in motion and to transmit rotary motion to other parts of the said mechanism.

469,895. Extension Electroller; Charles Deavs, of New York, Assignor to the Archer & Pancoast Manufacturing Company, of same place. Application filed Nov. 23, 1891. In an extension electrolier, the combination of a spring drum, wires or cable mounted thereon, plates secured to the drum and having conical hubs, arms having their lower ends fitting on said hubs, the spring for holding the arms in position, and conducting wires connected to the arms.

469,899. Trolley for Electric Railways; William H. Morgan, of Alliance, O., Assignor of three-fourths to Thomas R. Morgan, Jr., and John R. Morgan, of same place. Application filed June 24, 1891. A frame carrying two contact shoes, one of which is removably secured in place by a spring pressed plate.

469,917. Armature Winding for Dynamo Electric Machines; Rudolf Eickemeyer, of Yonkers, N. Y. Application filed June 1, 1891. A winding section for low tension armatures, composed of bendable metal in one or more separate lengths or



NO. 470,161.—CIRCUIT-INTERRUPTING DEVICE.

strands and shaped in the form of a loop having a straight long side, a straight short side, and correspondingly curved ends which are offset centrally in opposite directions.

469,940. Insulator; Charles N. Hammond, of Boston, Mass. Application filed Sept. 30, 1891. An insulator for electric wires, having a straight recess or passage through the same to receive the wire, and permit the latter to move endwise with freedom, and having a curved slot leading into the said recess or passage for the introduction of the wire, two overhanging lips or flanges being formed on one side of the slot.

469,949. Electric Soldering Tool; Johann Jakob Ritter, of Basle, Switzerland. Application filed Aug. 27, 1891. In an electrical apparatus for heating purposes, the combination with the solenoid and the casing in which it is mounted, of a carbon carrying tube, extending through and fixed to the movable core of the solenoid, and provided with refractory limiting jaws or stops for the carbon rod, the said carbon rod, a spring arranged in said tube behind the said carbon rod to press it up to said stops, a metal casing provided with a socket piece to receive and hold the article to be heated, a metallic bar having its end or point adjacent to the end or point of the carbon rod, and a spring arranged to keep the tube pressed forward normally, so that the carbon rod will be in contact with the bar.

469,995. Electromagnetic Annunciator; Francis W. Dunbar, of Newark, N. J., Assignor to the American Telephone and Telegraph Company, of New York. Application filed Nov. 23, 1891. An annunciator magnet whose helices have a relatively high coefficient of self-induction when the signal shutter is in its resting position, and a relatively low coefficient of self induction when the said signal shutter is released to give the signal.

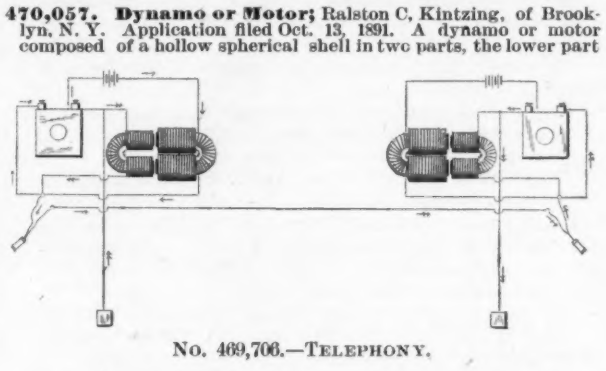
470,008. Electric Light Attachment for Lamps; Ralph C. Putnam, of Philadelphia, Pa., Assignor to J. E. Caldwell & Co. Application filed Sept. 5, 1891. An electric light socket, in combination with a collar having a plate at the top on which the base of the socket is seated, screws passing through said base and top, and a globe holder which is connected with the socket by an insulated ring which is secured to the socket and provided with a shoulder which bears against said holder.

470,013. Lightning Arrester; Charles F. Scott and Alexander Wurts, of Pittsburgh, Pa., Assignors to the Westinghouse Electric and Manufacturing Co., of same place. Application filed July 17, 1891. The combination with an electric circuit of one or more discharge plates connected with the conductors of said circuit and one or more movable discharge plates brought into proximity with the first named plate or plates in rapidly recurring succession.

470,014. Fuse for Electric Circuits; Charles F. Scott and Alexander Wurts, of Pittsburgh, Pa., Assignors to the Westinghouse Electric and Manufacturing Co., of same place. Application filed Oct. 16, 1891. The combination with a strip of lead or fusible metal or alloy, of a conductor in electrical contact therewith and having a different melting point, the two forming a fuse for electric circuits and being within heat-communicating distance from each other. (See illustration.)

470,038. Electric Link-Welding Machine; Charles L. Coffin, of Detroit, Mich. Application filed April 25, 1891. In an apparatus for electrically welding, working or forging links or rings, the combination, with an insulated support to hold the link, of means for compressing the link endwise, an electrical conductor adapted to connect the open ends of the link with one pole of a generator of electricity, an electrical conductor adapted to connect that point of the link opposite the ends with the other pole of said generator, and means for electrically connecting the ends of the link with the opposite side thereof across the opening of the link.

470,057. Dynamo or Motor; Ralston C. Kintzing, of Brooklyn, N. Y. Application filed Oct. 13, 1891. A dynamo or motor composed of a hollow spherical shell in two parts, the lower part



NO. 469,706.—TELEPHONY.

or hemisphere having base and bracket bearings for the shaft integral therewith, the opposing field magnets being attached to the hemispheres respectively.

470,073. Electric Battery; Erminio Ortelli, of Cadenabbia, Italy. Application filed Sept. 18, 1890. A galvanic battery comprising an outer impervious casing, inclosing a depolarizing chamber having a gas inlet, a gas and air outlet, and an outlet for liquid, a carbon vessel containing hydrochlorate of ammonia and serving as a porous vase and depolarizing plate, said vessel being placed in the depolarizing chamber, and a zinc plate placed in said carbon vessel.

470,080. Adjustable Suspension Apparatus for Electrical Translating Devices; Harry D. Sisson, of Pittsfield, Mass., Assignor of one-half to Charles H. Robinson, of same place. Application filed Sept. 24, 1891. An adjustable suspension apparatus for electric translating devices, comprising a base board of insulating material, two metallic standards affixed to said base board, a rotatable drum mounted in journal-bearings formed in said standards, one or more gravity pawls affixed to said drum, a flexible cord containing two electric conductors insulated from each other and connected to the opposite insulated journals of said drum, a spring tending to rotate said drum in a direction to wind said cord thereupon, and means for the attachment of circuit wires.

470,123. Voltaic Battery; Henry Inkson Harris, of London, England. Application filed April 4, 1891. A voltaic battery having the connections between the elements arranged under the bottom of the battery, and insulated from one another and from the contents of the cells.

470,129. Electric Railway Signal; William Holloway, Jr., of Wayne, Pa. Application filed Aug. 21, 1891. A railway signal comprising a pair of supplemental rail sections intermediate the main rails, a battery circuit connections between said battery and sections, an alarm on the locomotive brushes on the latter connected with the alarm and for contact with the rail sections, and a switch-rod bearing against and operating by its impact to bring a pair of terminals together when the switch is open.

470,143. Automatic Valve Controller; Washington H. Kilbourn, of Greenfield, Mass., Assignor to J. A. Spaulding, of Hartford, Conn. Application filed Dec. 18, 1890. In apparatus for preventing a cylinder head of a steam engine blowing out by over pressure, the combination, with the cylinder, a throttle valve, stop mechanism connected with said throttle valve and adapted to open and close it, and electrical devices for controlling said stop mechanism, of devices in the head of the cylinder included in electric circuit with said electrical devices and constructed and arranged in such manner that an undue pressure in the cylinder will cause them to operate to manipulate said circuit to operate the stop mechanism.

470,155. Electrical Device for Stopping Horses; Albert B. Holson, of Chicago, Ill., Assignor by direct and mesne assignments to the Holson Electric Harness and Supply Company, of Illinois. Application filed Feb. 14, 1891. In an electrical device for stopping horses, a normally open electric circuit including a source of electricity, contact points adapted to be placed within the nostrils, and a circuit closer, whereby an electric shock may be administered to the horse at or through the nostrils.

470,158. Electric Elevator; Carson J. Sturgeon, of Erie, Pa., Assignor to the Keystone Electric Company, of same place. Application filed Jan. 27, 1891. The combination in an electric elevator of an electric motor having an armature, field magnet cores, a wire coil wound on each of said magnet cores and connected in series with the armature, a second wire coil wound on each of said magnet cores in the same direction as the first-named coils and shunted around the armature, said coils being connected up with the incoming and outgoing lines in a manner whereby the current will traverse said coils in the same direction in parallel with a current-controlling mechanism, and a non-rheostated conductor between said current-controlling mechanism and said motor.

470,161. Circuit-Interrupting Device; Alexander Wurts, of Pittsburgh, Pa. Application filed April 23, 1891. A circuit interrupting device consisting of a switch, two sets of contact-plates therefor, a mechanical latch or detent normally holding said switch in contact with its respective contact-plates, carbon electrodes constituting a shunt-circuit around said switch, a solenoid in series with said switch, a core or armature operated by said solenoid for releasing the switch upon being traversed by an abnormal current, and means for separating the carbon electrodes after releasing said switch. (See illustration.)

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.